AOCMF

AO COIAC
COmprehensive Injury Automatic Classifier

Software for the classification and documentation of injuries

User Manual Version 4.0.0

Craniomaxillofacial Fracture Classification Module

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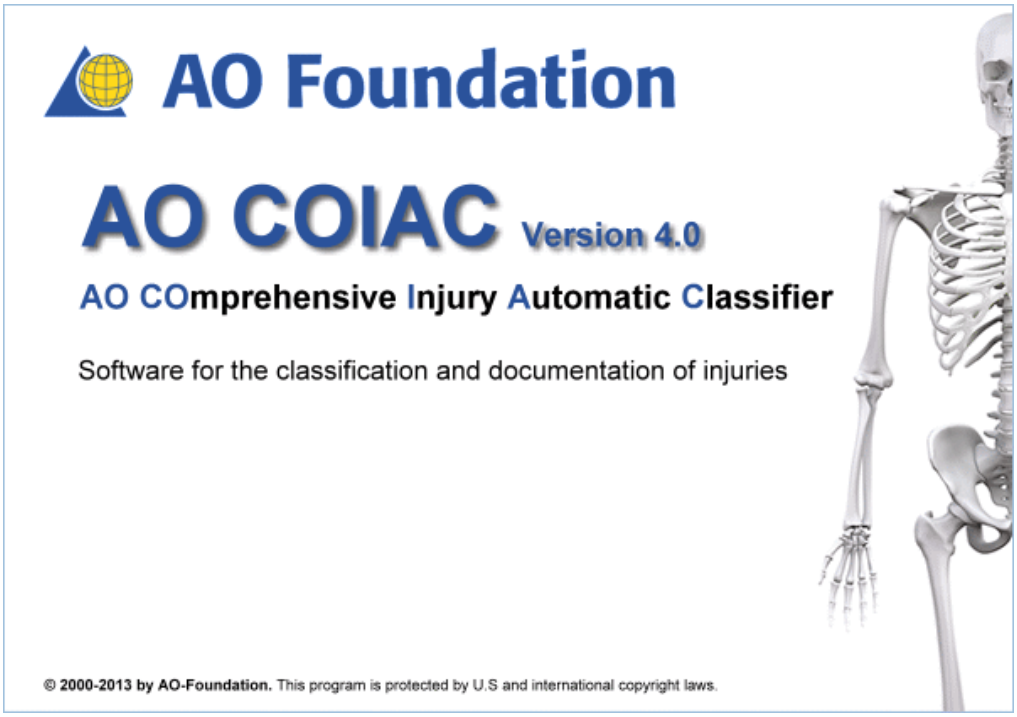
AO Foundation
AO COIAC Version 4.0
AO COmprehensive Injury Automatic Classifier
Software for the classification and documentation of injuries
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1. Introduction

The AO Foundation developed the software named AO COIAC (AO COmprehensive Injury Automatic Classifier) to facilitate the diagnosis, coding and documentation of injuries. This software version includes the long bone fracture classification (adult and paediatric) as well as the new AOCMF fracture classification modules.

The AOCMF Classification Group developed a hierarchical 3-level craniomaxillofacial fracture classification system (1). The fundamental Level-1 distinguishes 4 major anatomical units including the mandible (code 91), midface (92), skull base (93) and cranial vault (94); Level-2 relates to the location of the fractures within defined topographical regions within each units; Level-3 relates to fracture morphology in these regions regarding fragmentation, displacement, and bone defects, as well as the involvement of specific anatomical structures.

An introduction to the CMF classification module in AO COIAC has been presented (2). This manual highlights in more details its functionality. The general features of the AO COIAC software for classification and documentation are presented in a separate main manual.

Important note = this manual do not present and explain the CMF classification system in details. The user should read the related tutorials published in a special issue of the Journal of Cranio-maxillofacial Trauma and Reconstruction (CMTR). Reference to the specific tutorials will be made within appropriate sections of this manual.

The use of AOCOIAC for CMF fracture classification should be referenced as follows:

Audigé L., Cornelius P.C., Kunz C., Buitrago-Tellez C., Prein J. (2013) AO COIAC COmprehensive Injury Automatic Classifier Software: User Manual Version 4.0.0 Craniomaxillofacial Fracture Classification Module, AO Foundation, Davos, Switzerland, 43 pages

or

Audigé L., Cornelius P.C., Kunz C., Buitrago-Tellez C., Neff A., Di Ieva A., Rudderman R., Frodel J., Prein J. (2014) AO classification system for fractures of the craniomaxillofaxial skeleton: software solution for documentation, Craniomaxillofacial Trauma and Reconstruction, in press

2. CMF classification module

The CMF classification module can be accessed by double-click on the cranium of the adult skeleton either using the training tab (no classification data will be saved) (Figure 1) or using the fracture tab (for case documentation after registering patient demographics and trauma event). It is organized and presented to facilitate fracture coding according to any of the 3 levels of the classification (Figure 2).

Figure 1

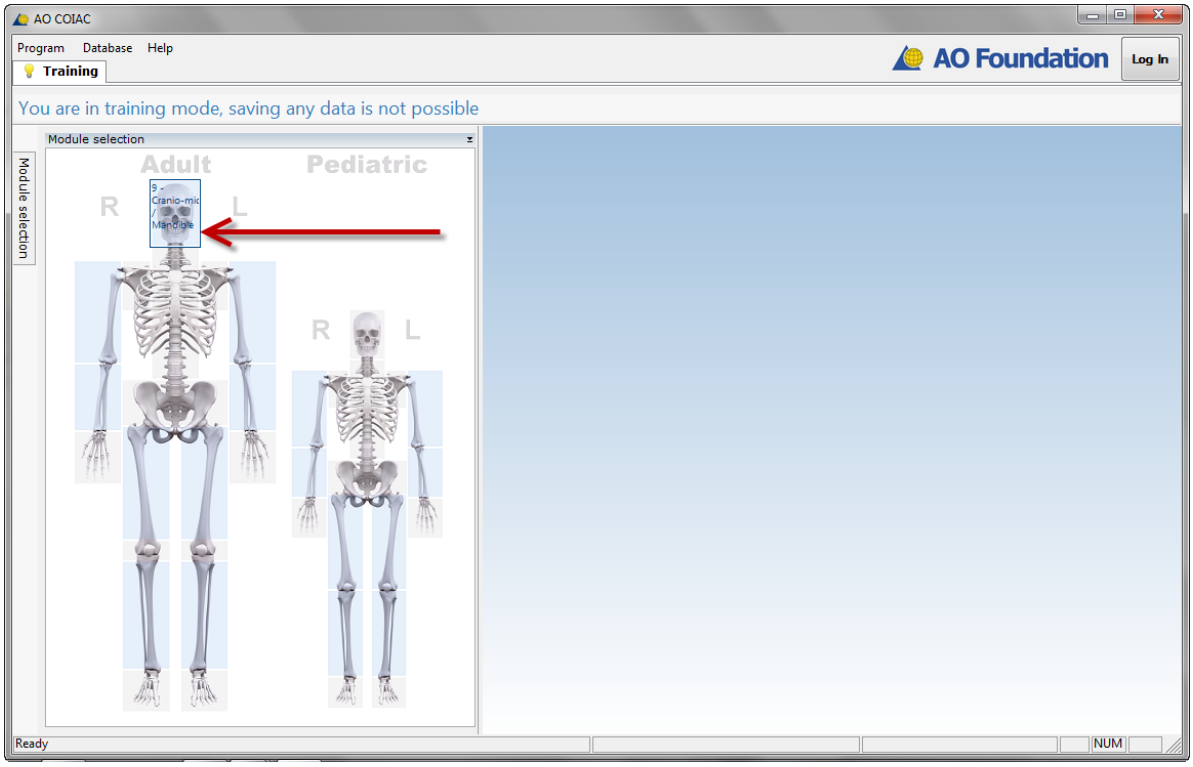
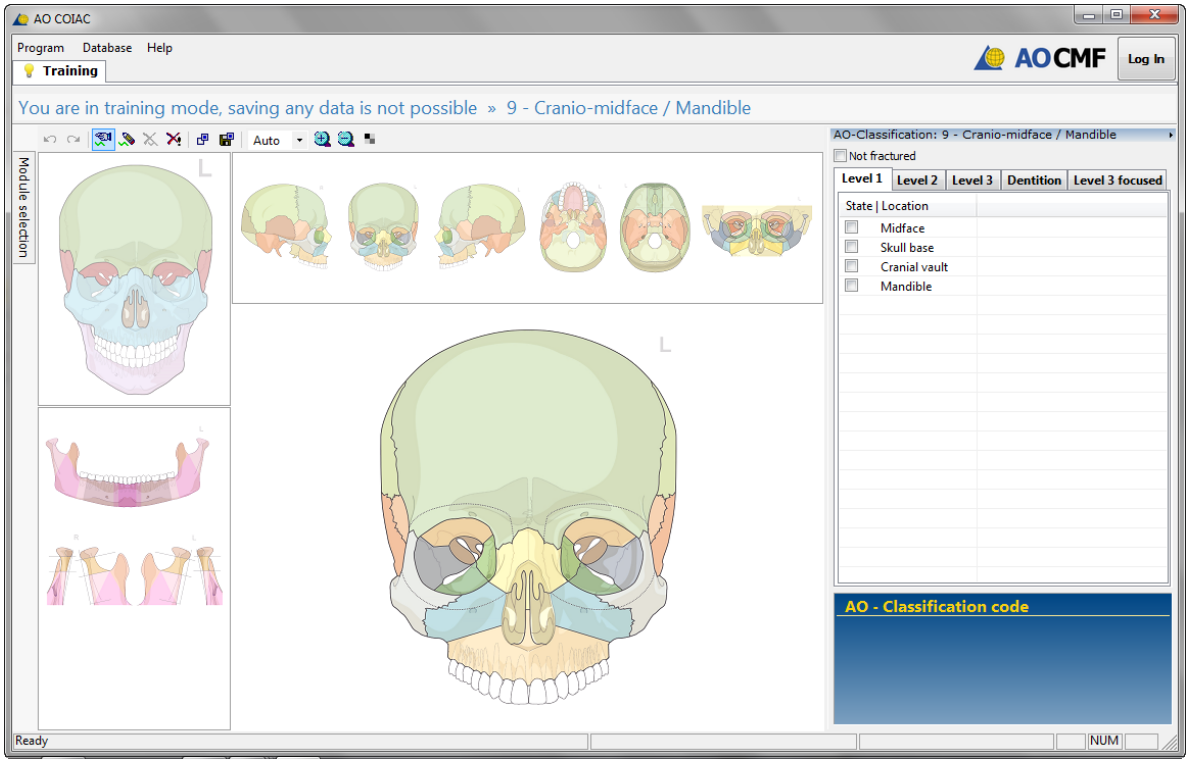


Figure 2



On the top-left corner of the windows interface, the skull is presented for Level-1 classification; on the left column and top row, respectively, illustrations of the mandible and cranium give access to Level-2 and Level-3 classifications. By mouse-click on the desired illustrative view, a corresponding larger illustration is presented in the central window with delimitations of Level-2 regions or Level-3 subregions depending on the selected view. On the top row a panoramic illustration of the zygomas, orbits and nose delimits Level-3 subregions for the cranium. Similarly on the left column, an illustration of both condylar processes is used for Level-3 classification of condylar process subregions (head, neck and base).

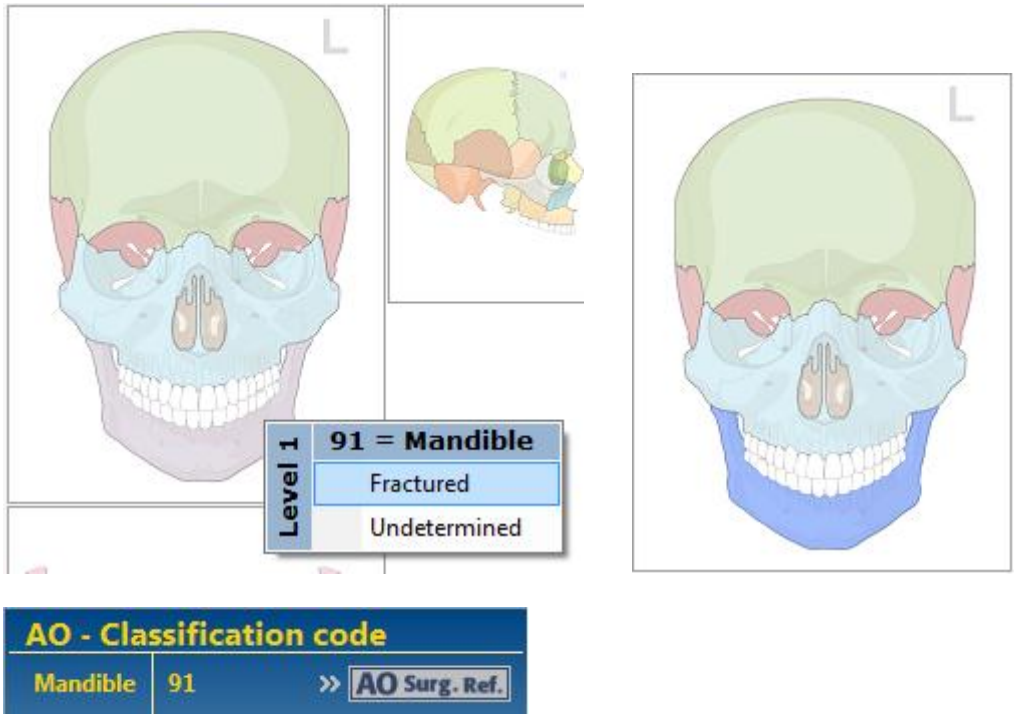
Fracture classification may be implemented directly on the selected illustrations or using the side table on the right-side of the screen window.

3. Mandibular fractures (91)

3.1. Level-1 system

Identification of patients with mandibular fractures can be implemented on the Level-1 system from the skull window interface (Figure 3). The mandible is highlighted in blue and the code 91 is shown on the bottom right window.

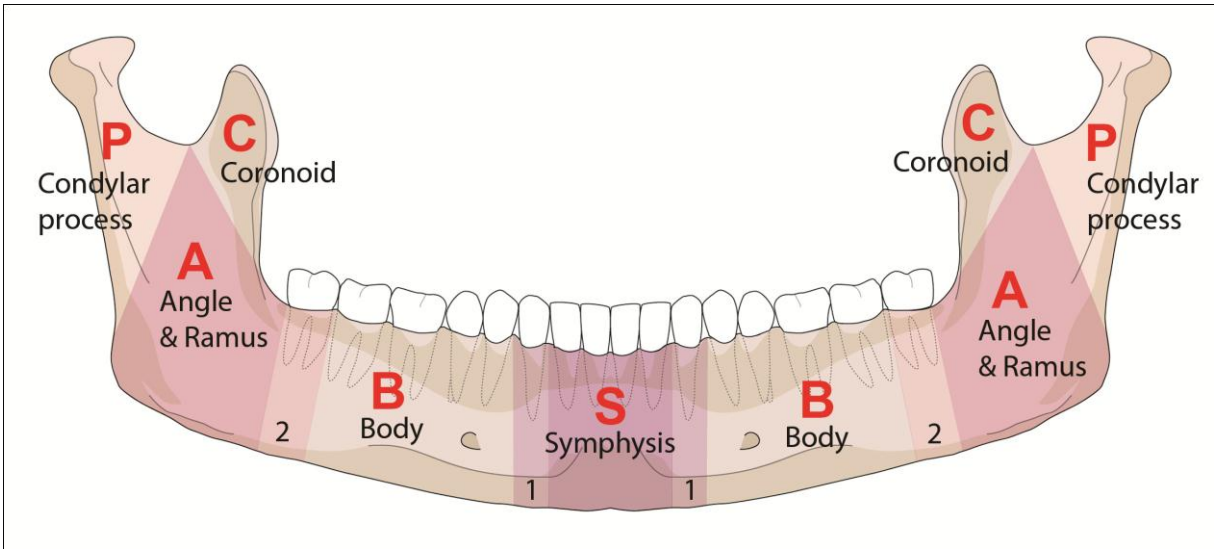
Figure 3



3.1. Level-2 system

The defined regions for the mandible are described in details by Cornelius et al (3) and illustrated in Figure 4.

Figure 4



Reproduced from Cornelius et al (3).

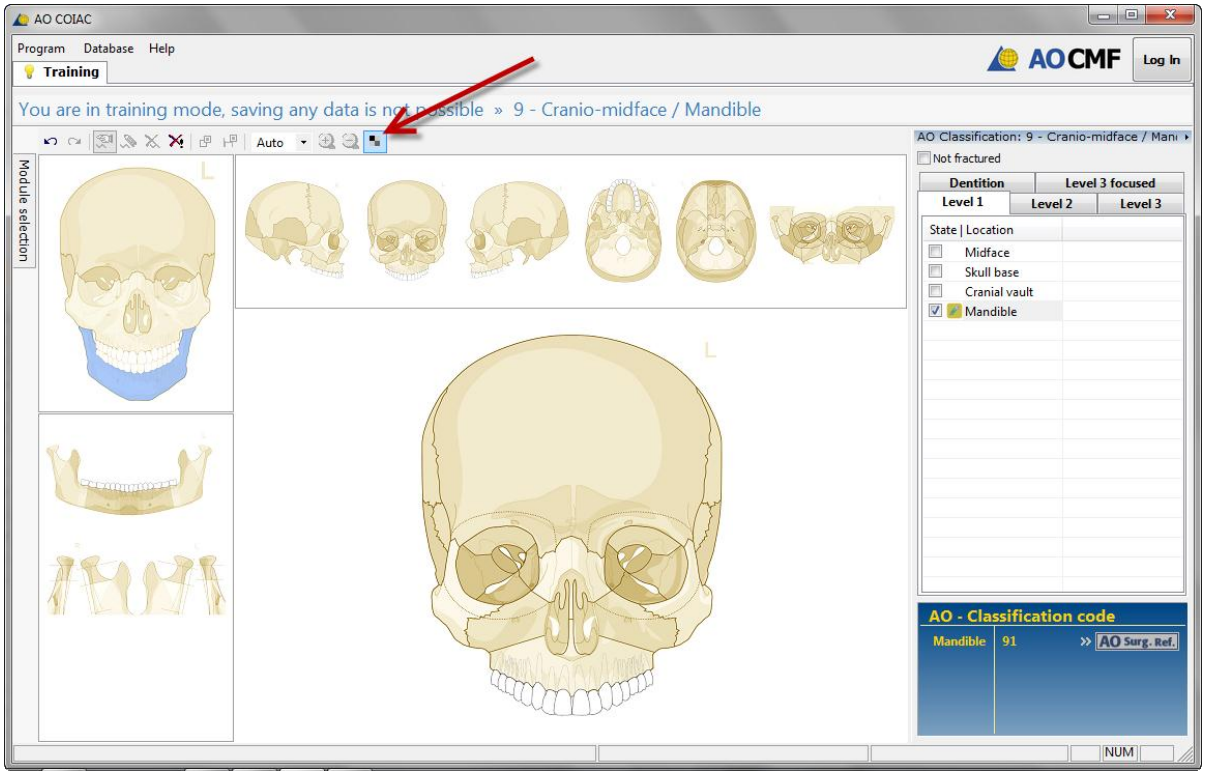
Four transitional zones between adjacent symphysis and body subdivisions (1 = anterior transitional zones), and between adjacent body and angle/ramus subdivisions (2 = posterior transitional zones) are defined and the rules for classification of fracture location and continuity across subdivisions are applied within AO COIAC.

3.1.1. Panoramic view

To classify mandibular fractures according to the Level-2 system, the panoramic view of the mandible should be selected by clicking on the corresponding view on the left column (Figure 3). This view should be presented in the central window for classification.

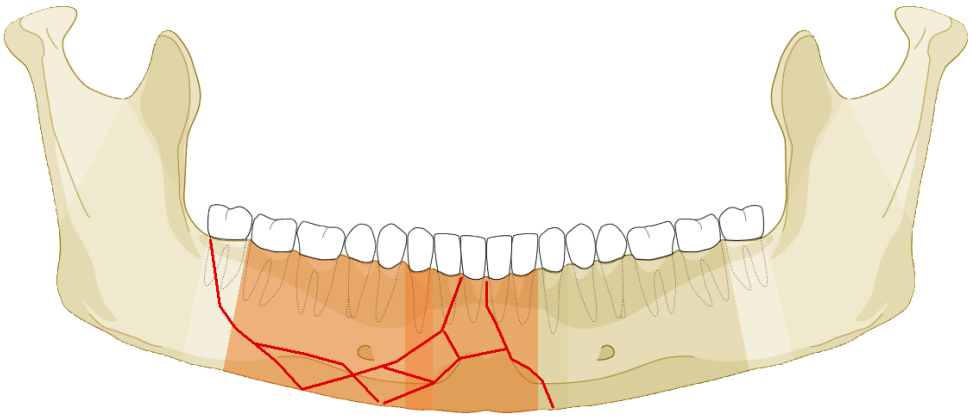
Note = we recommend to switch the view from color to black and white by clicking on the related icon on the tool bar

Figure 5



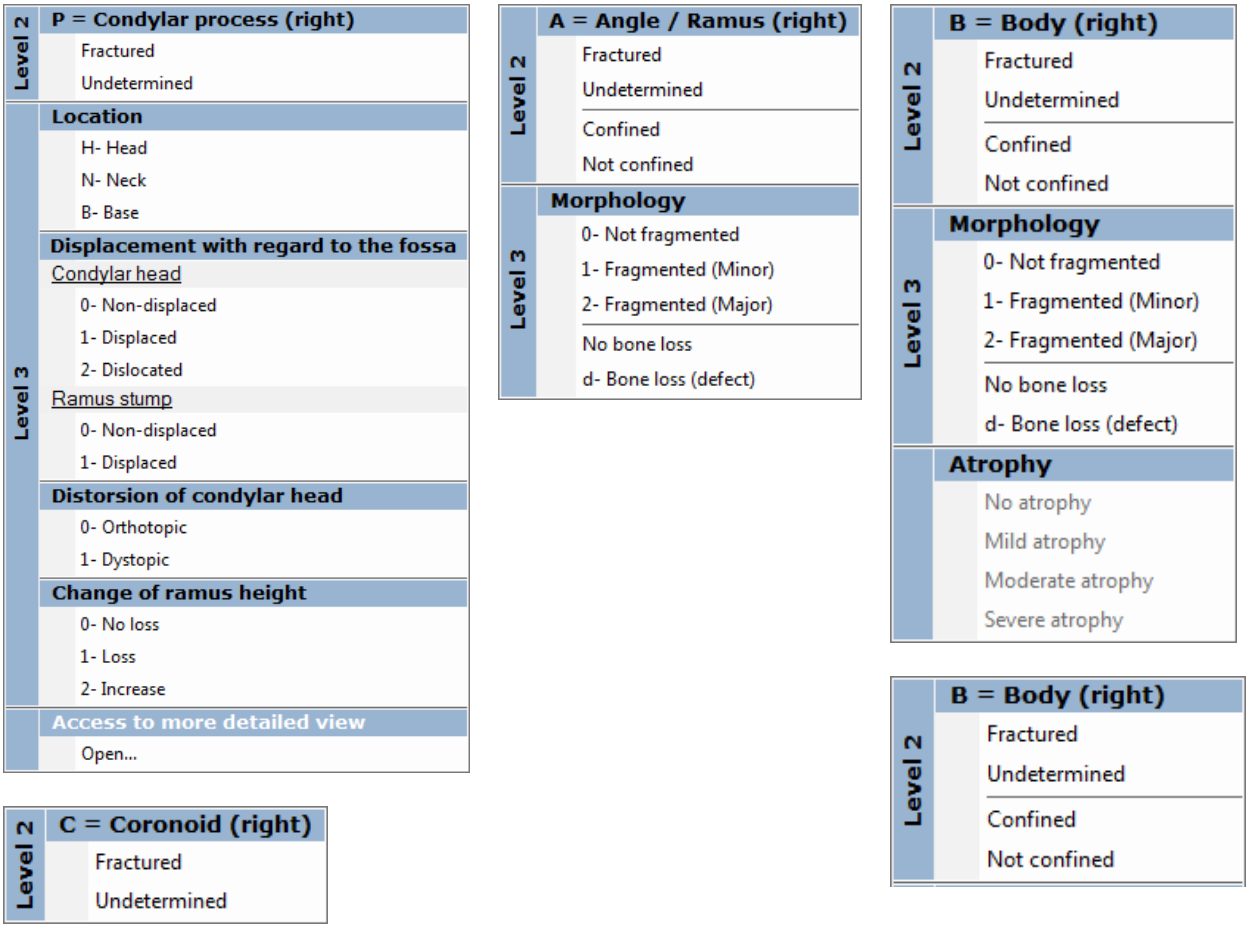
To support the classification process, the mouse pointer can be transformed into a pen by double-click within the central window anywhere outside the illustration (and vise-versa); the pen can be used to draw the fracture line(s)(see the main user manual). The regions or subregions corresponding to these drawn lines are selected as fractured, in accordance with rules and definitions (e.g. location inside the transition zones of the mandible)(Figure 6).

Figure 6



A double-click with the mouse pointer on a region or subregion of interest opens up menu windows tabulating respective Level-2 and Level-3 descriptors to specify the fracture in greater detail (Figure 7).

Figure 7



Important note = When selecting one or more Level-2 regions as fractured, all other regions or subregions that are not explicitly categorized as fractured are considered as not fractured by default. The same principle applies to the classification of Level-3 subregions.

3.1.1. Dentition

The dentition status can be specified from the menu windows that can be opened by double mouse-click on the respective tooth or teeth. The classification categories are illustrated in Figure 8 along with their graphical presentation on the panoramic view. The tooth status can be set as "undetermined" as shown for tooth 42.

When a series of teeth needs to be specified as "absent (before trauma)" to document partial or full edentualism, it is more convenient to use the side table on the right-side of the AO COIAC window. This can be achieved by checking the box in front of the respective tooth numbers (Figure 9).

Figure 8

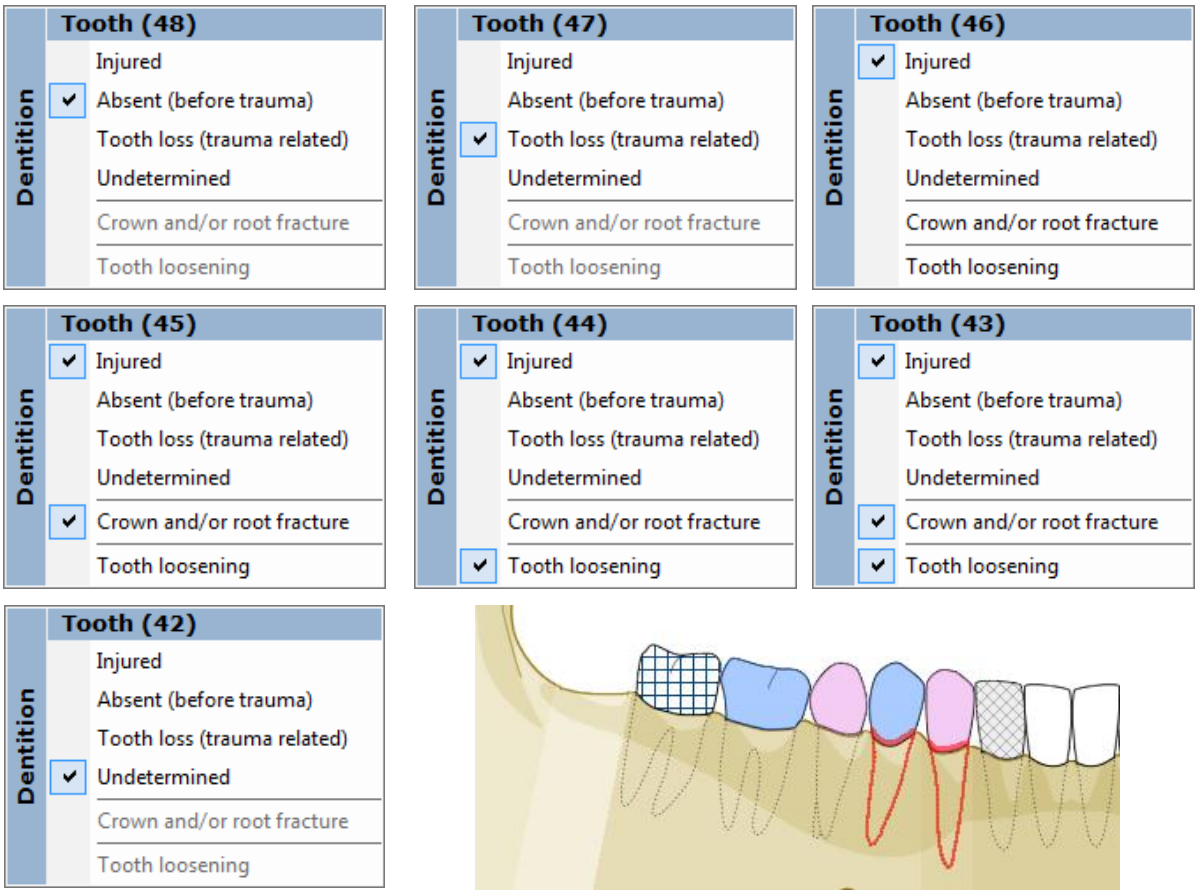
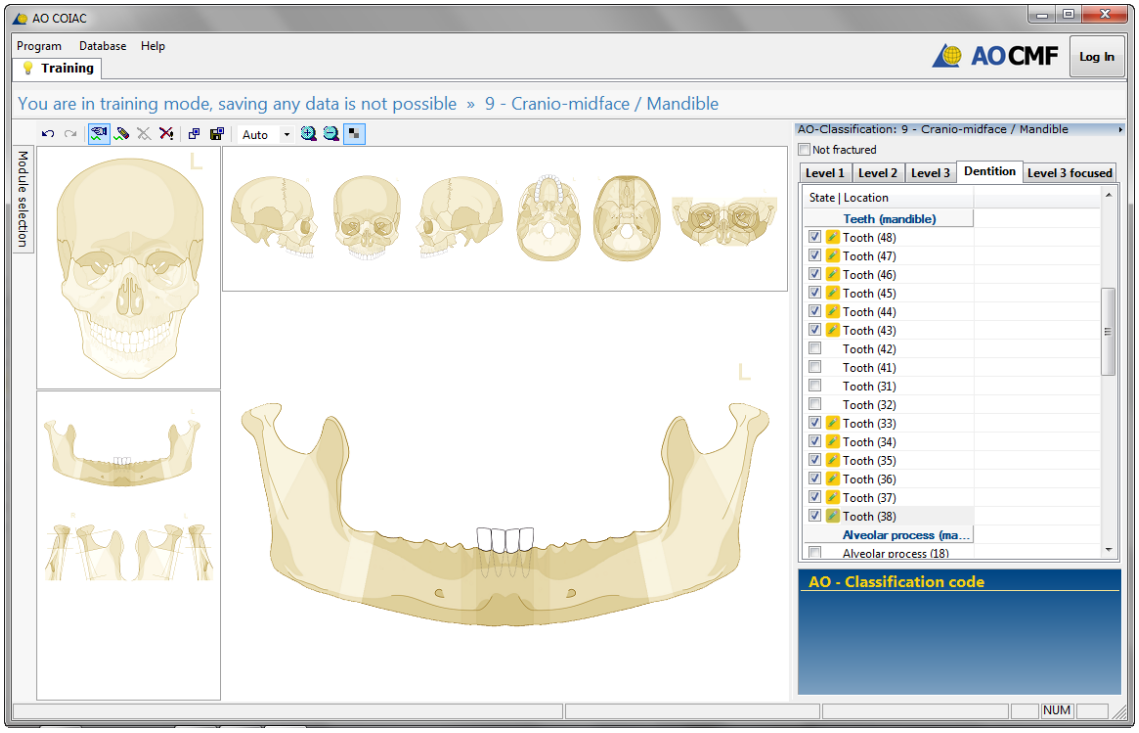


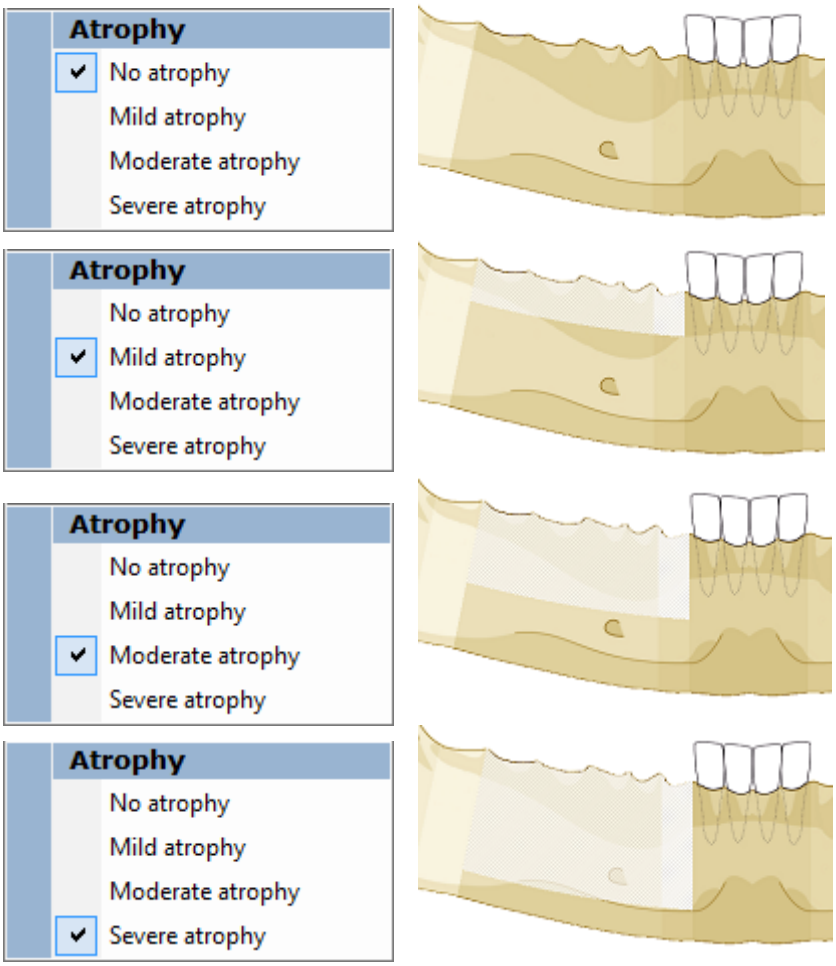
Figure 9



3.1.2. Mandibular atrophy

The level of mandibular atrophy can be specified separately for the Body (B) and Symphysis/Parasymphisis (S) regions, as soon as one tooth is absent (before trauma) in the concerned region. With no teeth missing, the classification dialogue window (Figure 7) for mandibular atrophy remains inactive. According to the level of atrophy specified, part of the concerned region is masked in white for illustration.

Figure 10

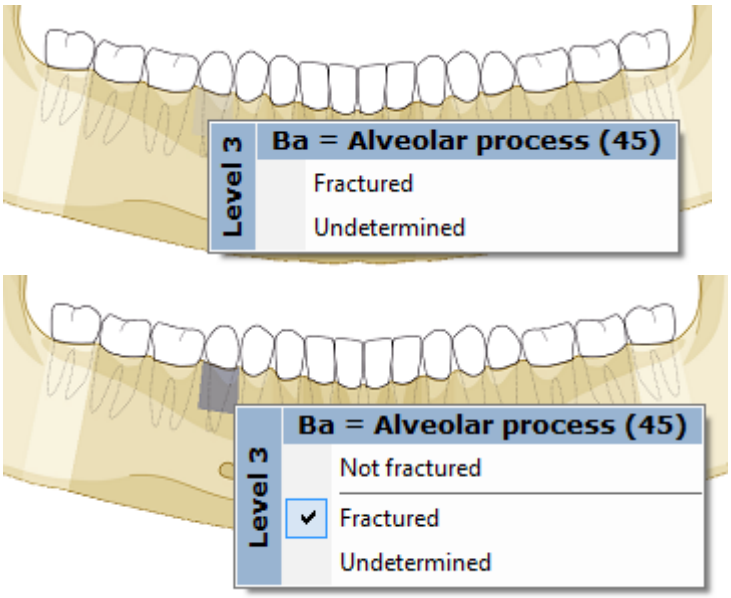


3.1.3. Fracture location

Alveolar fractures

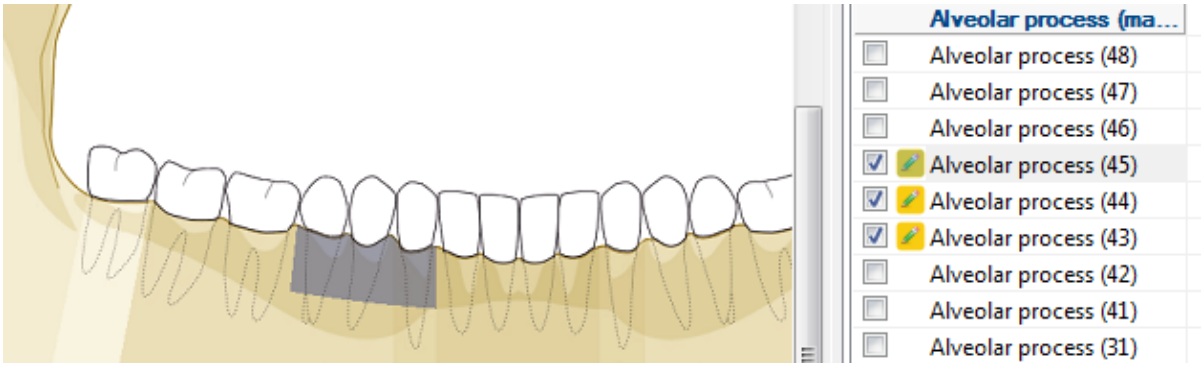
Alveolar fractures can be specified from the menu window accessible by double-click on the respective tooth root. The fractured alveolar bone is highlighted in violet (Figure 11).

Figure 11



When an alveolar process fracture involves several contiguous teeth, each involved tooth root should be classified similarly. It is more convenient to use the side table on the right-side of the AO COIAC window. This can be achieved by checking the box in front of the respective tooth numbers (Figure 12).

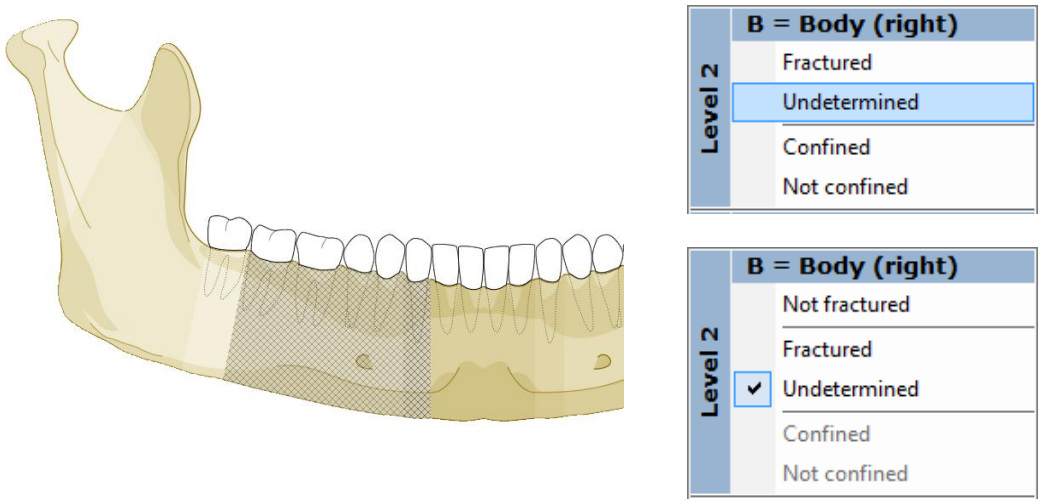
Figure 12



Fractured regions

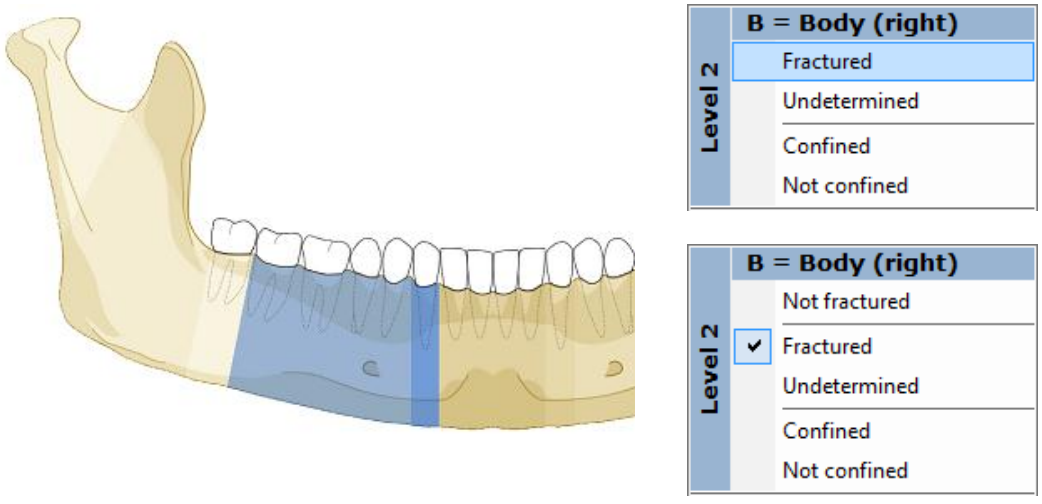
Regions potentially involved by the fracture scenario that are difficult to analyze or un-evaluable (e.g. due to lack or shortages in diagnostic imaging) can be indicated as "undetermined". These regions are marked with a grid pattern (Figure 13)

Figure 13



The Level-2 classification involves specifying the fractured regions. This is achieved by selecting "Fractured" on the respective menu windows. By clicking outside these windows, they will close and the involved region(s) will be highlighter in blue (Figure 14). To reverse this selection either use the undo icon available on the icon bar , or select "Not fractured" within the menu window that is opened following a new double-click on the concerned region.

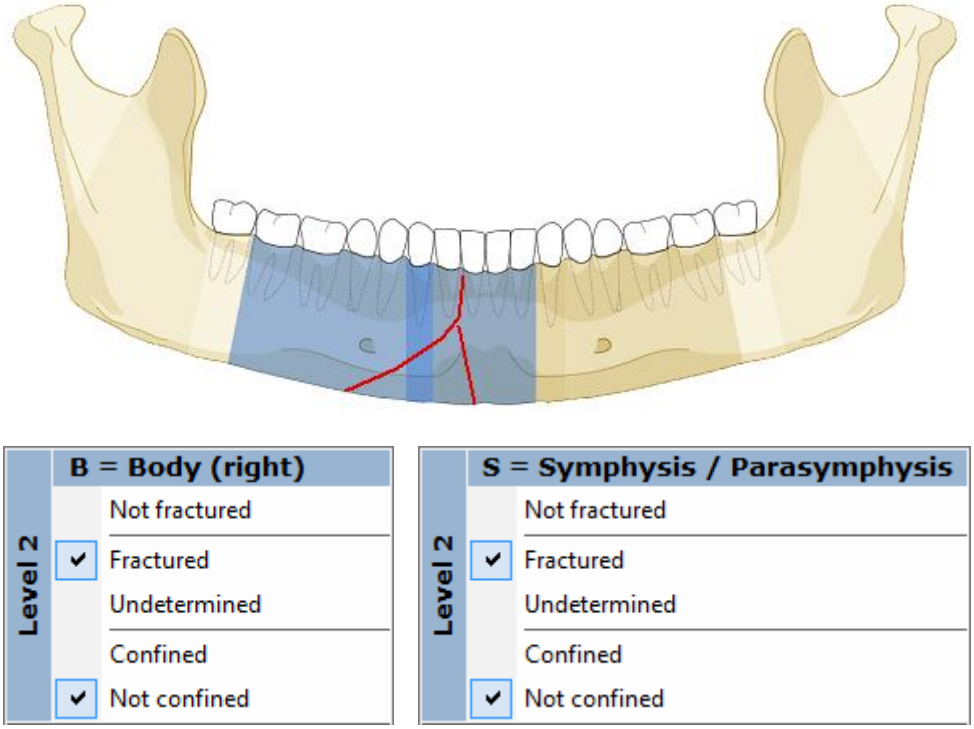
Figure 14



Fractures of the Angle/Ramus (A), Body (B) and Symphysis/Parasymphysis (S) can be located within their respective region – they are described as "confined" - or extent to their adjoining region – they are the described as "not confined". This classification is implemented within the respective Level-2 menu windows.

Note = Condylar Process (P) and Coronoid (C) regions are not concerned in this specification. If one of the three regions A, B and S is coded with a "not confined" fracture, one of its adjoining regions must be coded similarly (Figure 15).

Figure 15



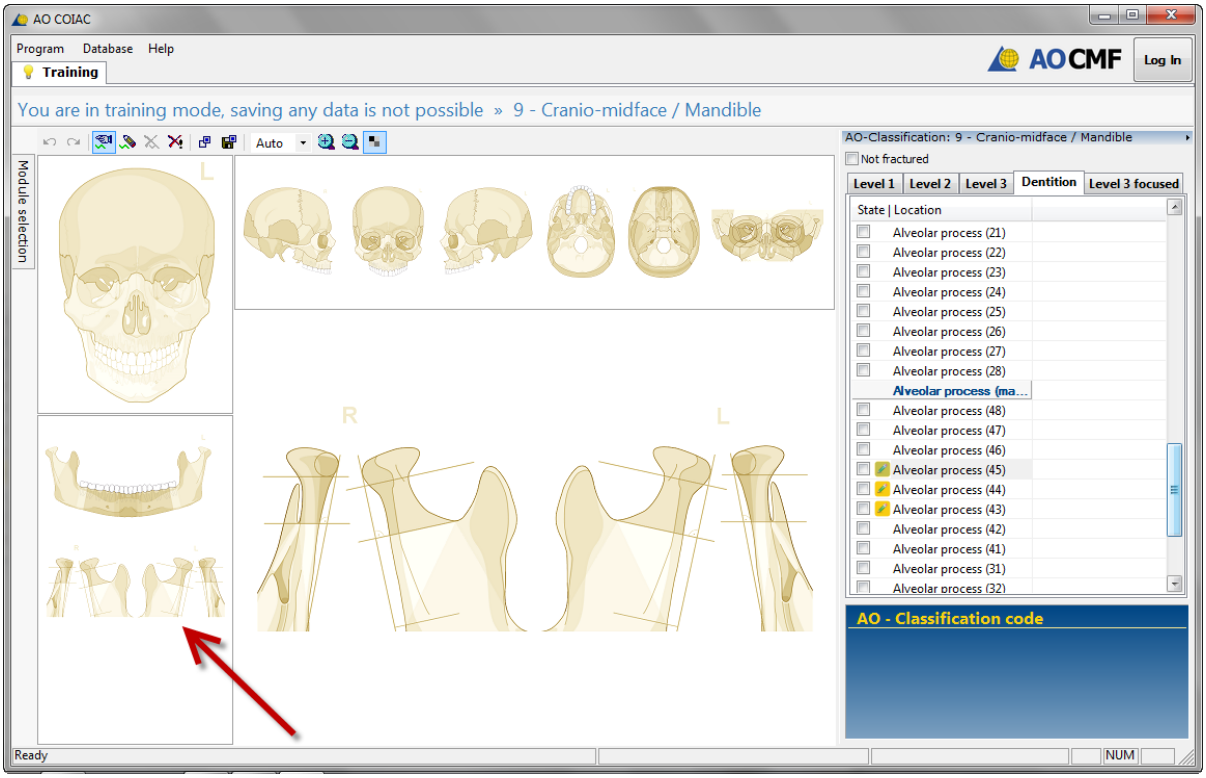
3.1. Level-3 system

The Level-3 system is used to specify items related to fracture morphology. They are available for coding using the menu windows (Figure 7). In addition for fractures of the Condylar Process (P), a new illustration presenting the two processes in postero-anterior and lateral views is used (Figure 16). This view is accessible by clicking on its smaller format on the left column (red arrow). There is no Level-3 item for the Coronoid (C).

Note = the classification process may be restricted to the Level-1 or Level-2, not taking the features of fracture morphology within Level-3 into account. If Level-3 is applied, it is reasonable that all affected regions are classified uniformly at this level to comply with a clear and concise layout.

Marking of a Level-3 descriptor such as the fragmentation grade in a region or subregion, however, will automatically retroactivate the Level-1 and Level-2 classification and can be used as a shortcut and timesaver in the coding process.

Figure 16



3.1.1. Angle/Ramus, Body, Symphysis/Parasymphysis

The Level-3 system for the mandible regions A, B and S is described in details by Cornelius et al (4).

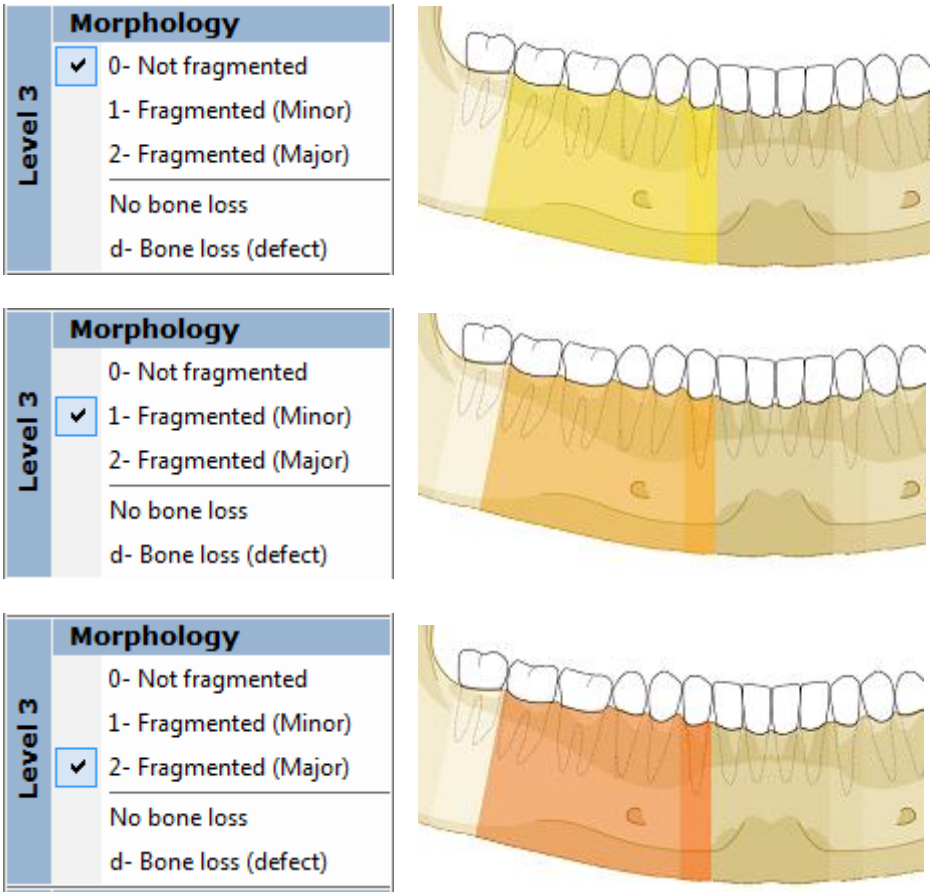
Fragmentation

Fractured A, B and S regions can be classified according to the level of fragmentation in 3 classes. The definition of these classes is the same for B and S regions however differ for A regions. The user should consult the relevant tutorial to find these definitions.

A color scheme is used to represent the gradation of fragmentation (Figure 17):

- Yellow = not fragmented
- Orange = minor fragmentation
- Red = major fragmentation

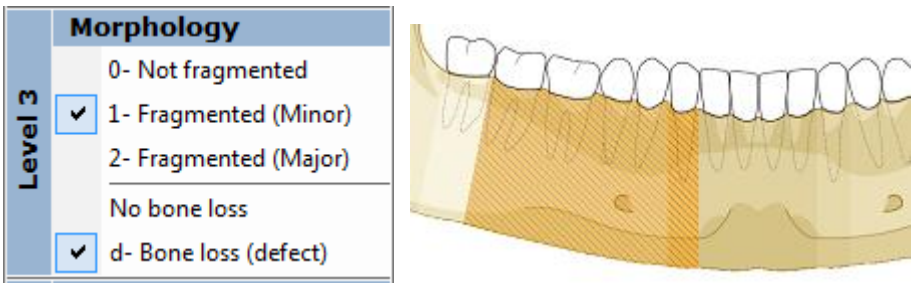
Figure 17



Bone loss

Bone loss can be specified using the diagnose windows just below the fragmentation. Regions identified with bone loss (d = defect) are marked with additional stripes superimposed to the color scheme of fragmentation (Figure 18).

Figure 18



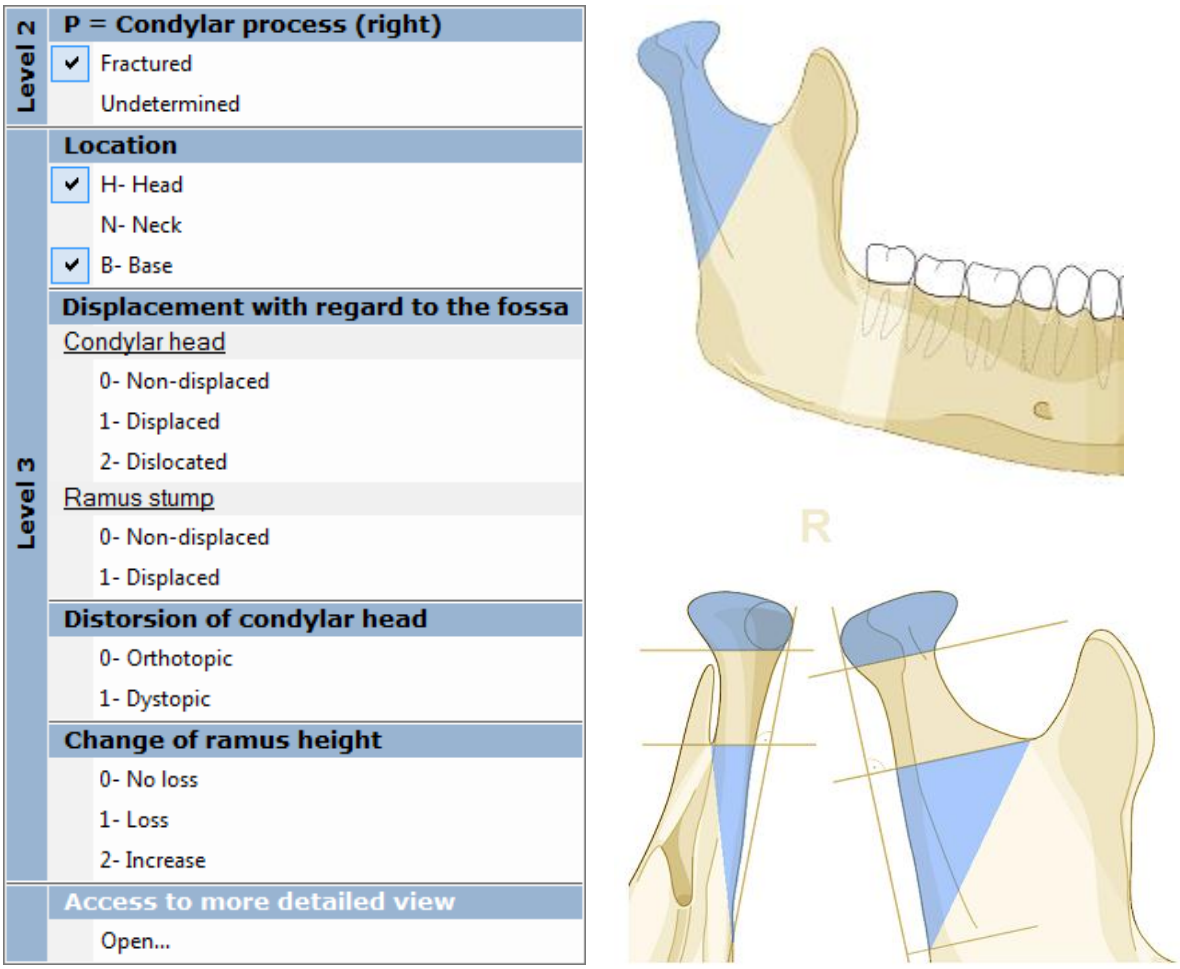
3.1.1. Condylar Process

The Level-3 system for the condylar process region P is described in details by Neff et al (5).

Subregions

Fractures of the condylar process (P) can be specified according to their course within the three subregions Head (H), Neck (N) and Base (B) which are illustrated in the detailed Level-3 view (Figure 19). It is possible to specify separate fracture within each of the three subregions.

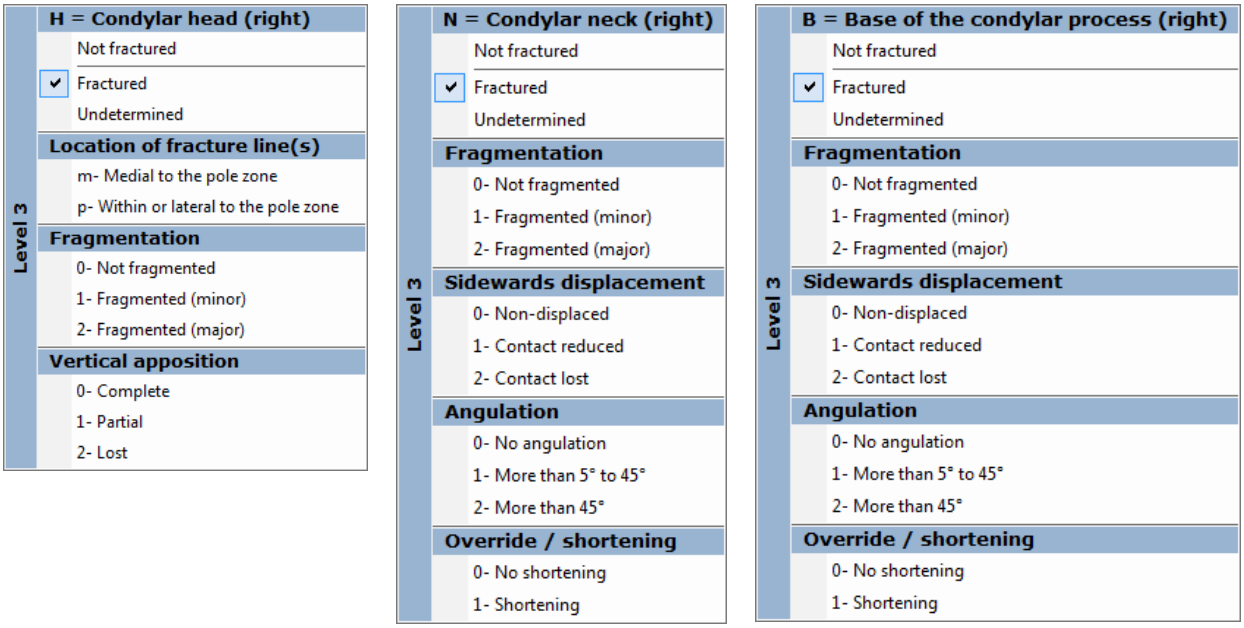
Figure 19



The detailed Level-3 view can be accessed also from the bottom link "Open…" within the menu window presented in the Figure 19 above.

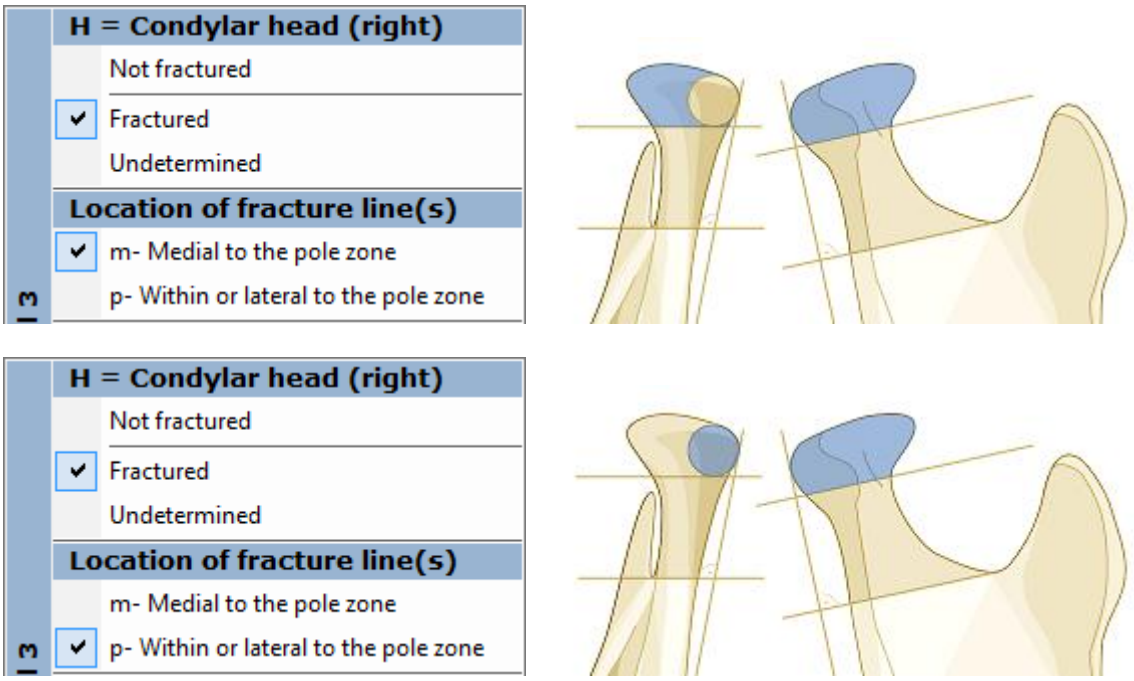
The subregions can be classified as fractured directly from this detailed view by clicking on the respective subregions and selecting "fractured" on the associated menu window (Figure 20).

Figure 20



Fractures of the Condylar Head (H) can be further classified according to the location of the fracture line(s) medial to the pole zone (m), or within or lateral to it (p) (Figure 21). When only the location of a fracture is specified, and not its fragmentation, the involved subregions are highlighted in blue.

Figure 21



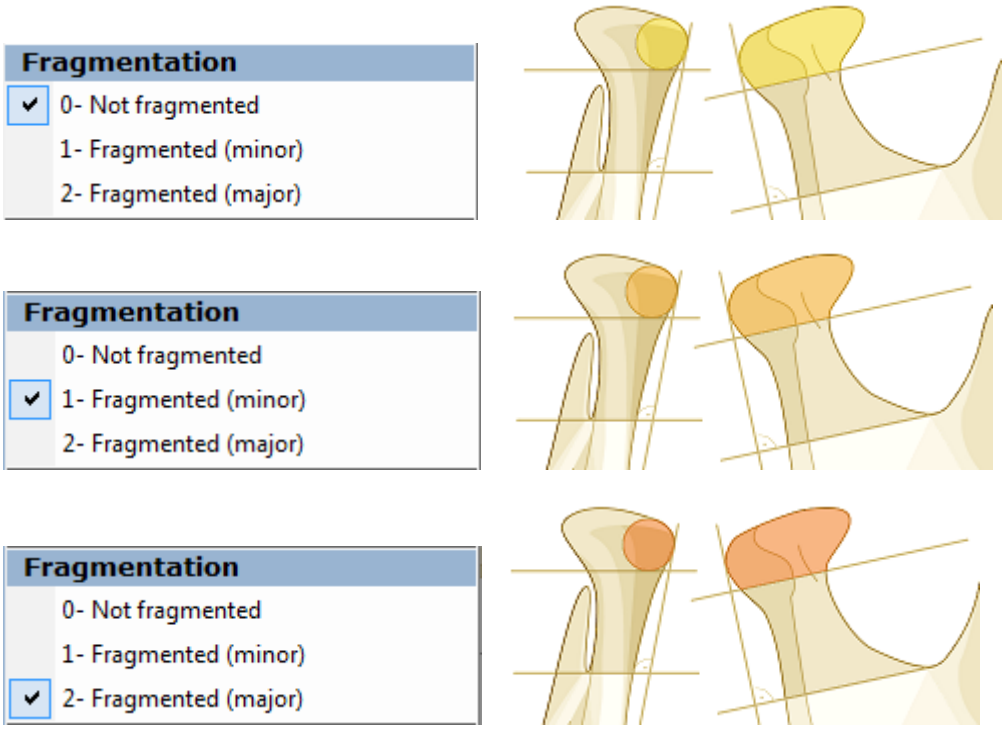
Fragmentation

For each subregion, the level of fragmentation is specified in one of three categories as for the other A, B and S regions, however using specific category definitions. The relevant tutorial paper should be consulted for more details (5).

The same color scheme is used to represent the gradation of fragmentation (Figure 22):

- Yellow = not fragmented
- Orange = minor fragmentation
- Red = major fragmentation

Figure 22



Displacement

Displacement parameters are related to:

- Injuries the Condylar Process (P) as a whole, or
- Fractures within the specific subregions.

In the first situation their documentation is done using the menu window from the panoramic view (Figure 19); they include:

- The position of the condylar head with regard to the fossa
- The position of the ramus stump with regard to the fossa
- Distortion of the condylar head
- Change of the ramus height

In the second situation their documentation is done using the respective menu window of the subregions from the detailed view (Figure 20); they include:

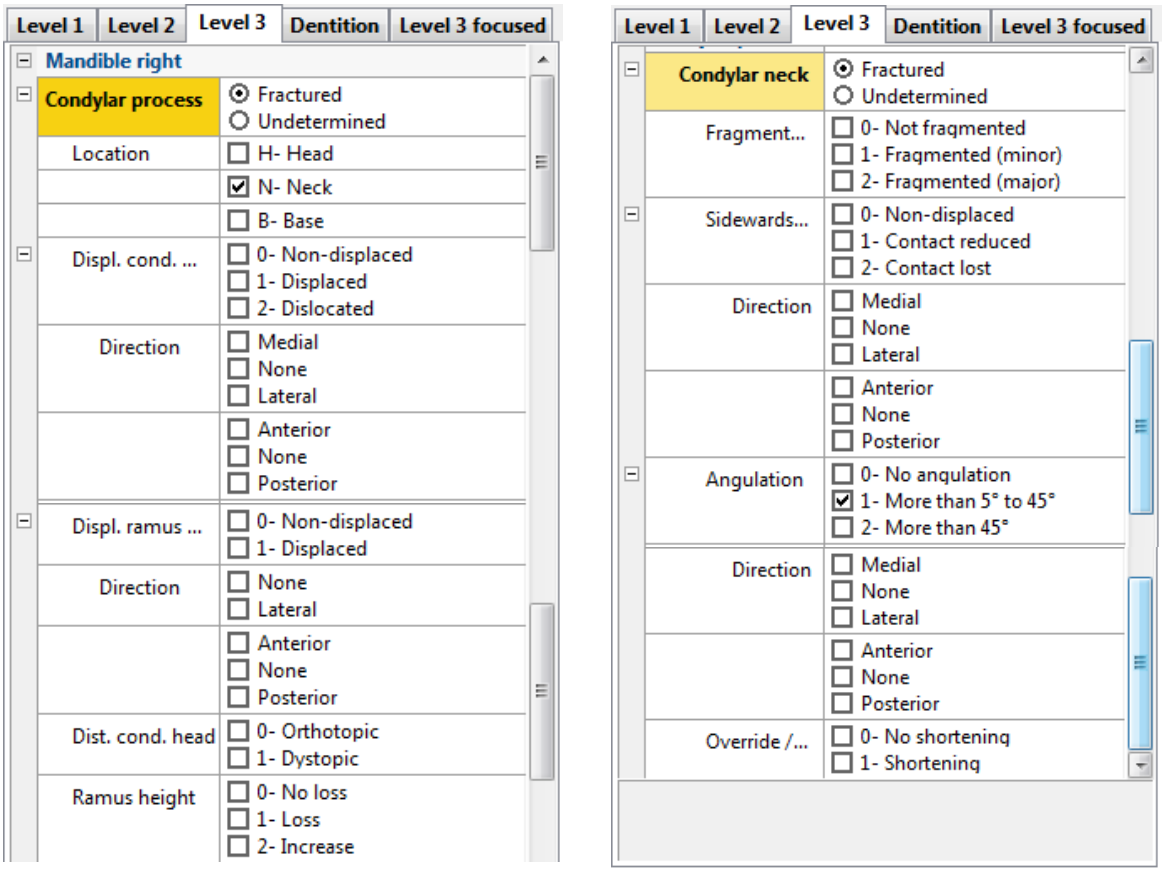
- Head:
  - Loss of vertical apposition
- Neck and Base:
  - Sidewards displacement
  - Angulation
  - Override / Shortening

The direction of displacement for condylar process fractures can also be specified according to two parameters related to antero-posterior and medio-lateral direction, for each of the following displacement parameters:

- Position of the condylar head with regard to the fossa
- Position of the ramus stump with regard to the fossa
- Sidewards displacement of neck and Base fractures
- Angulation of neck and Base fractures

This classification is however not performed using the menu windows but via the entry table on the right side of the screen window after selecting the Level-3 tab (Figure 23).

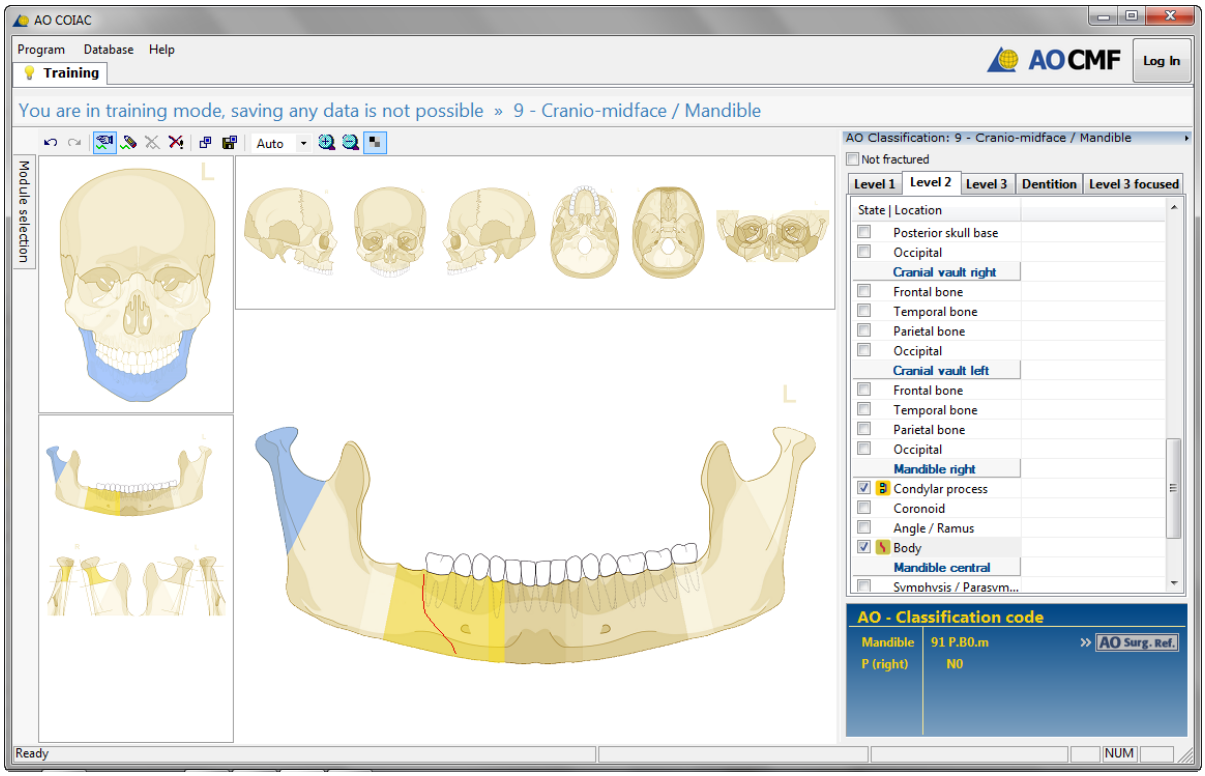
Figure 23



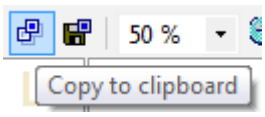
3.1. Fracture code, illustrations and Surgery Reference

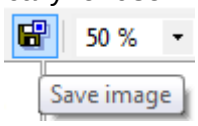
After completion of the classification, the fracture code is presented within the bottom-right screen window (Figure 24). The codes can be copied to the computer clipboard following double-click of the mouse over them.

Figure 24



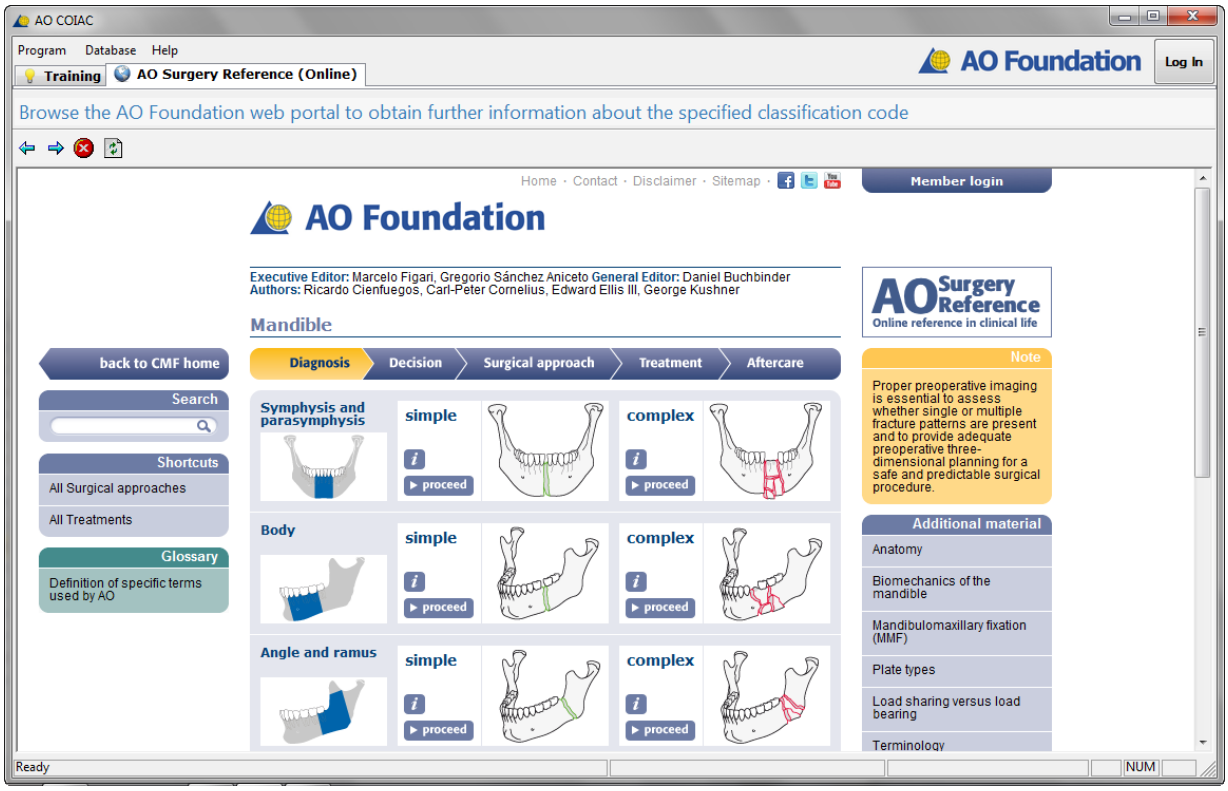
Mandible 91 P.B0.m
P (right) N0

The related illustrations can be copied or saved electronically for use in publications and presentations using the icon bar 

or 

Direct access to the AOCMF Surgery Reference portal (Figure 25) at a remaining basic level of the classification is provided by selecting the icon "AO Surg. Ref." on the right of the fracture code (Figure 24).

Figure 25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Shortcuts
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All Treatments
Glossary
Definition of specific terms used by AO
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Decision
Surgical approach
Treatment
Aftercare
Symphysis and parasymphysis
simple
complex
proceed
Body
Angle and ramus
Note
Proper preoperative imaging is essential to assess whether single or multiple fracture patterns are present and to provide adequate preoperative three-dimensional planning for a safe and predictable surgical procedure.
Additional material
Anatomy
Biomechanics of the mandible
Mandibulomaxillary fixation (MMF)
Plate types
Load sharing versus load bearing
Terminology
Ready
NUM

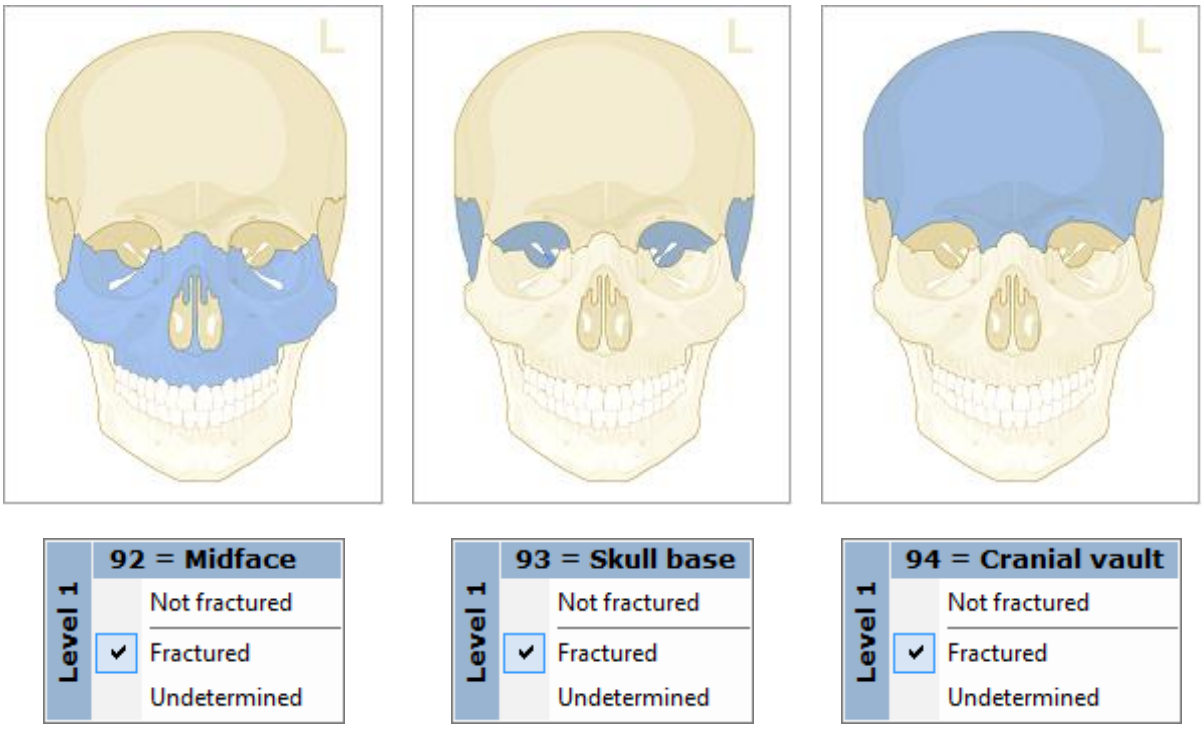
4. Fractures of the cranium

4.1. General overview

4.1.1. Level-1 system

Identification of patients with fractures of the midface, skull base and cranial vault can be implemented on the Level-1 system from the skull window interface (Figure 26). The respective fractured area is highlighted in blue.

Figure 26

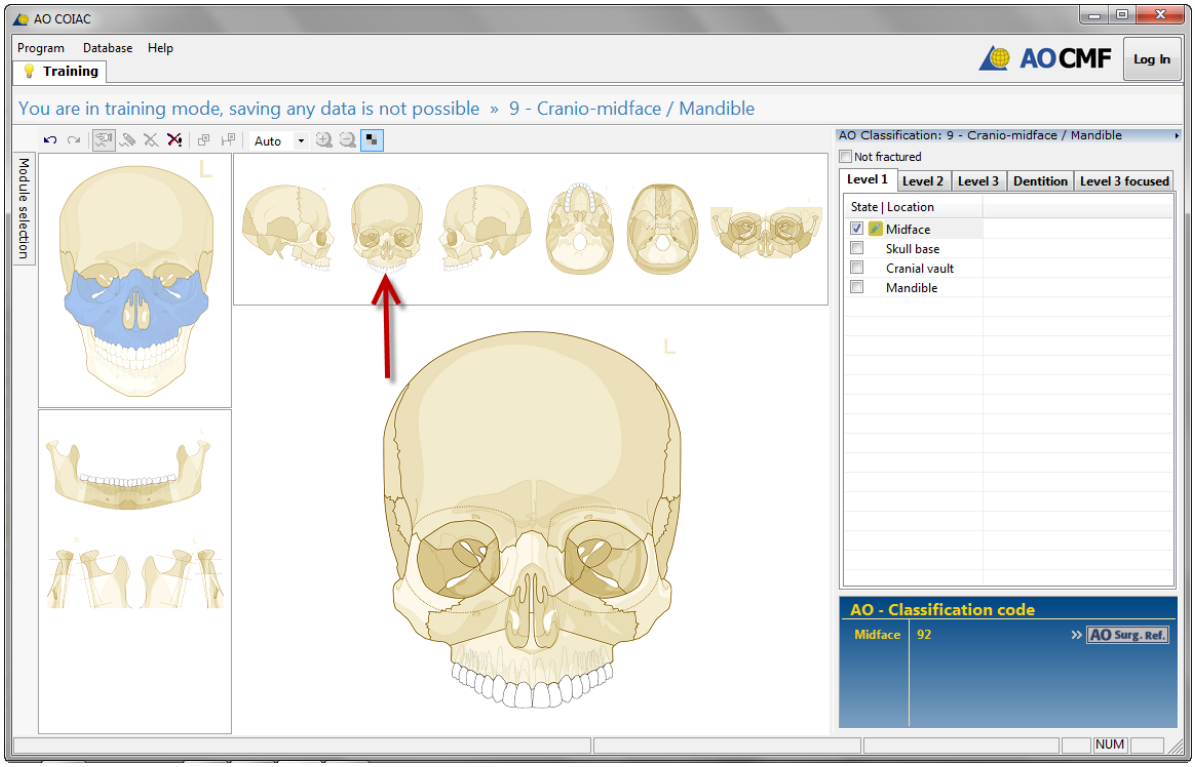


4.1.2. Level-2 system

The Level-2 system allows specifying the fracture location within predefined regions. It is presented and explained in details in the corresponding tutorials for the midface (6) and skull base / cranial vault (7).

To classify fractures of the cranium according to the Level-2 system, the skull must be selected by clicking on any appropriate view on the top row, except the detailed view of the orbits, zygoma and nose on its right-hand side. The selected view should be presented in the central window for classification (e.g. the frontal view in Figure 27).

Figure 27



The classification process is similar to that presented for the mandible. By double-click on any delimited bone region a specific dialogue widow is presented for classification including Level-2 as well as some Level-3 parameters (e.g. for the Zygoma in Figure 28).

4.1.3. Level-3 system

The Level-3 system allows classifying fractures according to relevant morphological characteristics. Level-3 parameters pertinent to the involved region(s) are presented for classification within the menu windows mentioned above (Figure 28).

Other Level-3 parameters are related to subregions delimited within the detailed view of the zygomas, orbits and nose that is accessed by double click on the right-hand side icon on the top row (Figure 29 in color scheme).

Figure 28

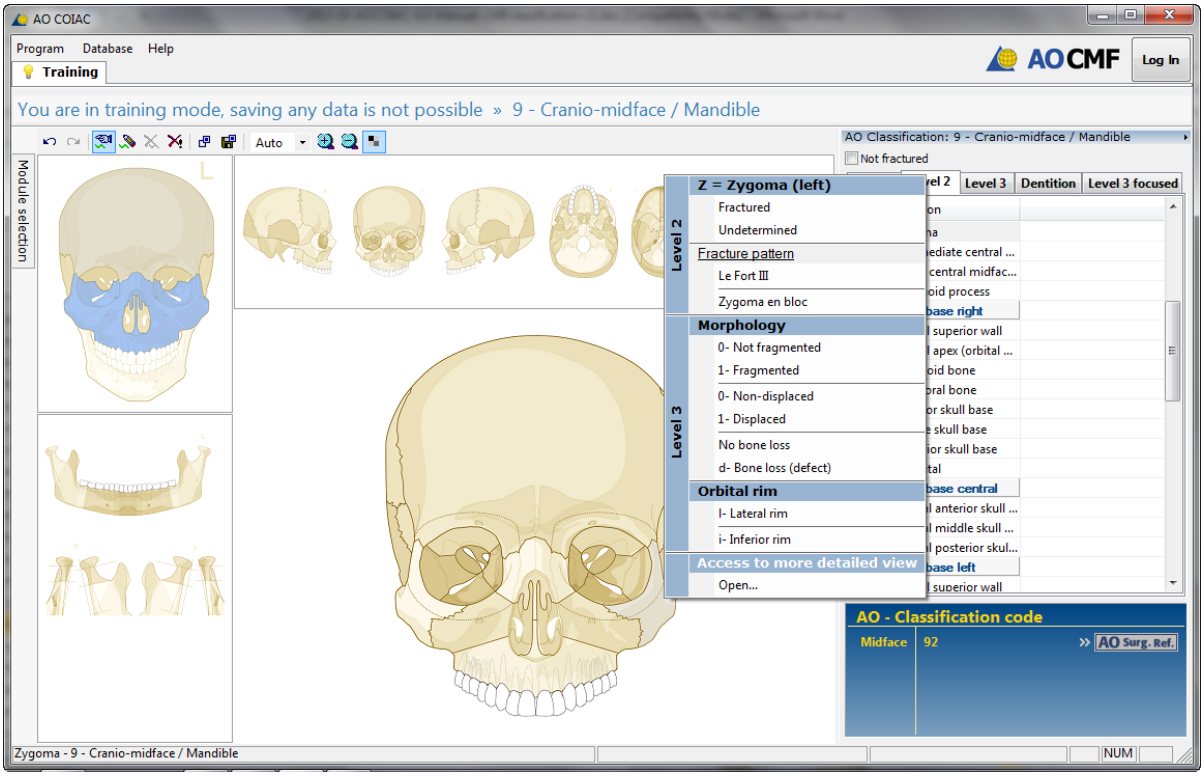
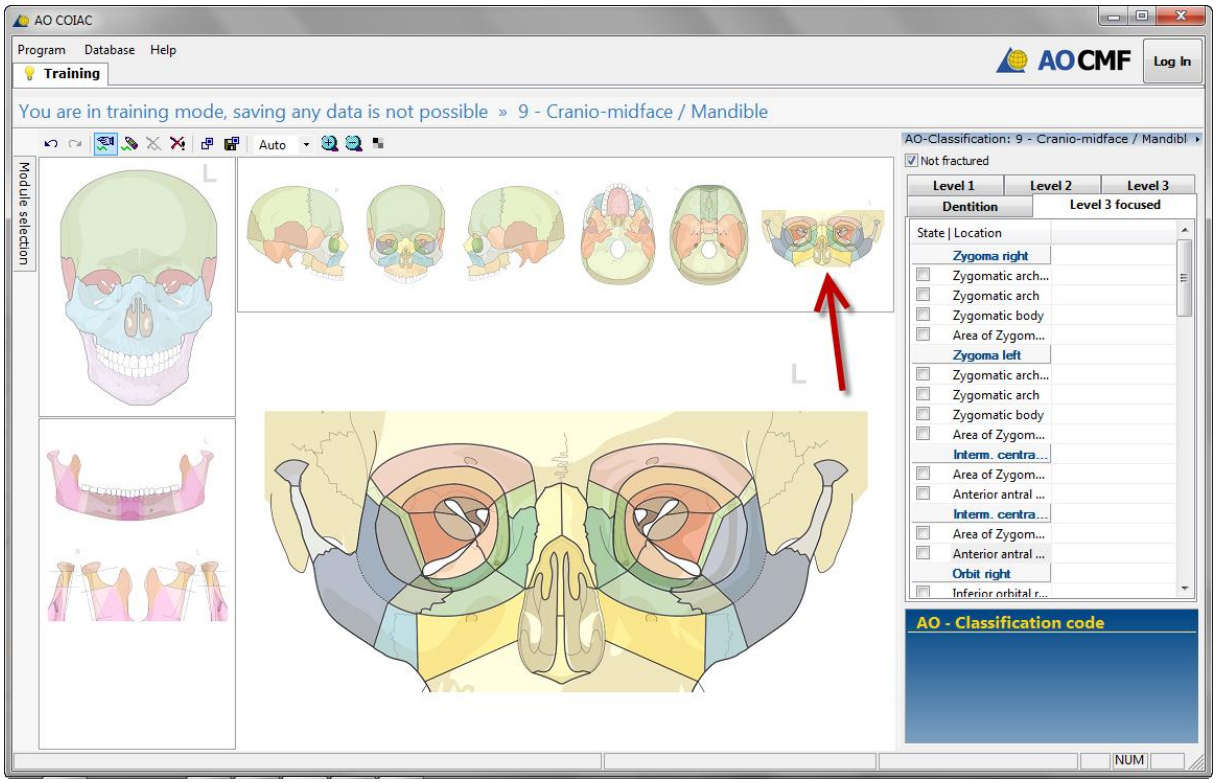


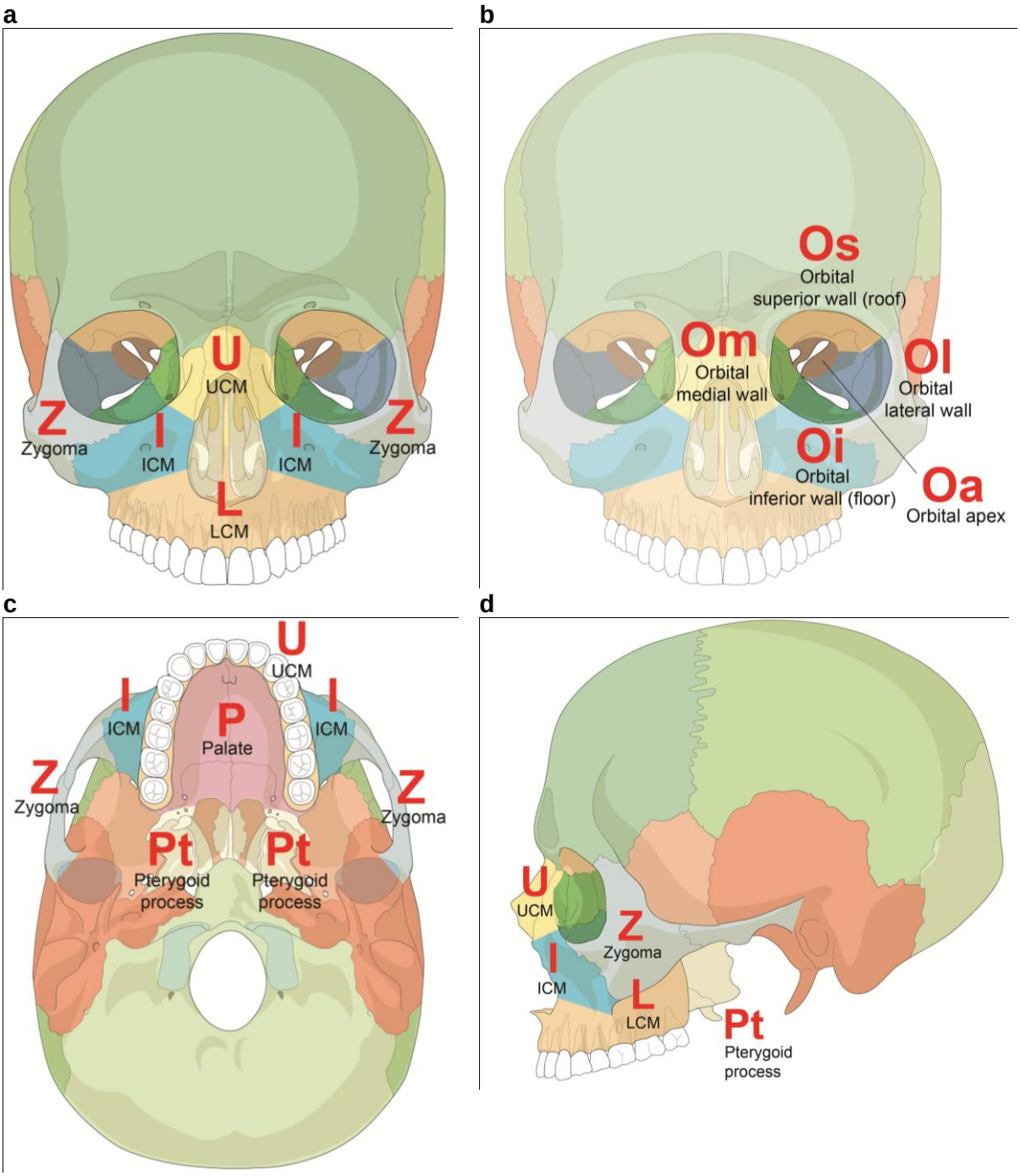
Figure 29



4.2. Fractures of the midface (92)

The defined regions for the midface are described in details by Kunz et al (6) and illustrated in Figure 30.

Figure 30



UCM = Upper Central Midface - Nasal skeleton including bone and nasofrontal maxilla; ICM = Intermediate Central Midface - Parapiriform maxilla and infraorbital maxilla; LCM = Lower Central Midface - Maxillary bodies including infrazygomatic maxilla; Z = Zygoma / zygomatic arch. Reproduced from Kunz et al (6)

4.2.1. Classification menu windows

The classification menu windows specific to the central midface regions (LCM, ICM and UCM) are presented in Figure 31, and to the zygoma, pterygoid process and palate regions in Figure 32.

Figure 31

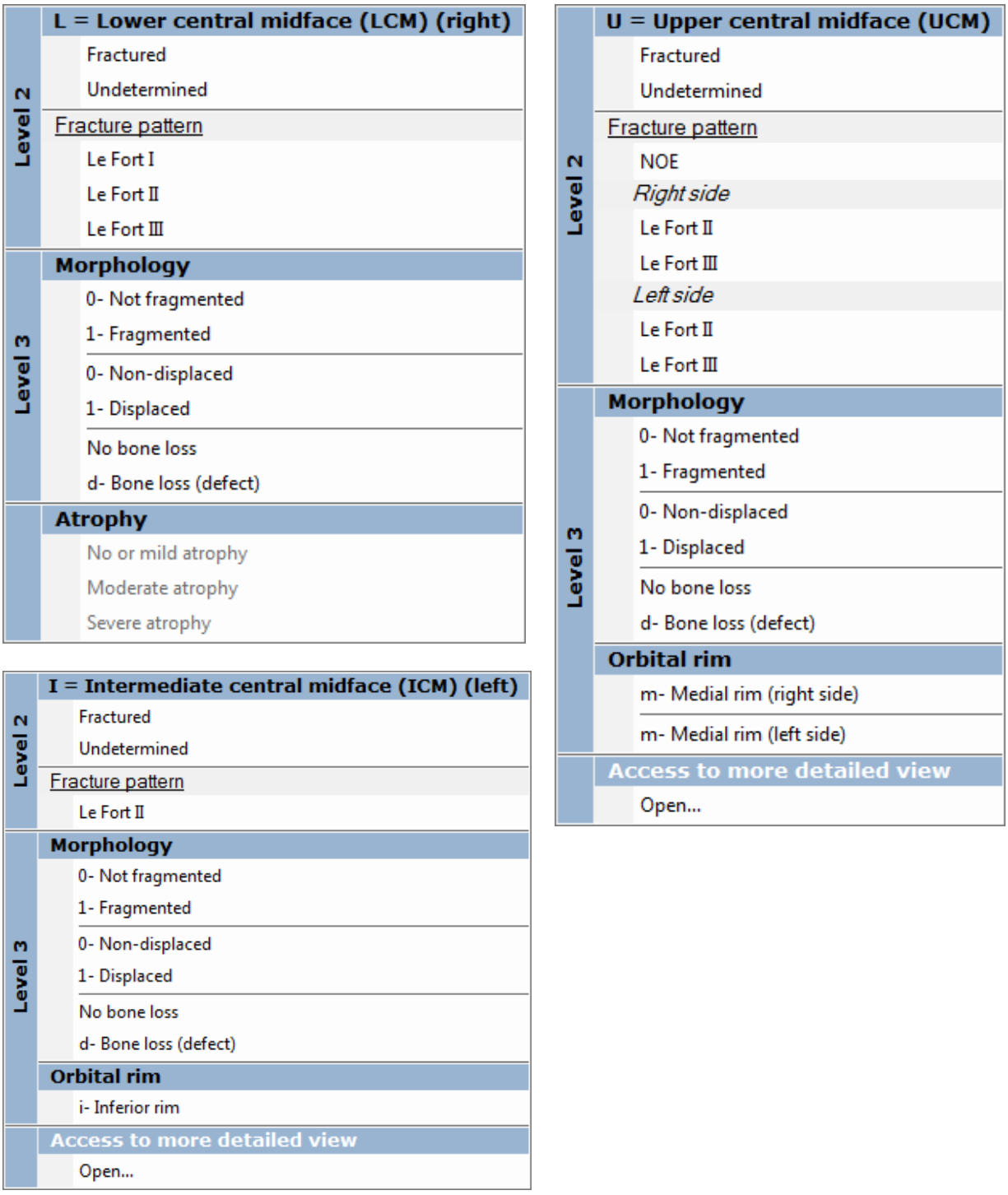
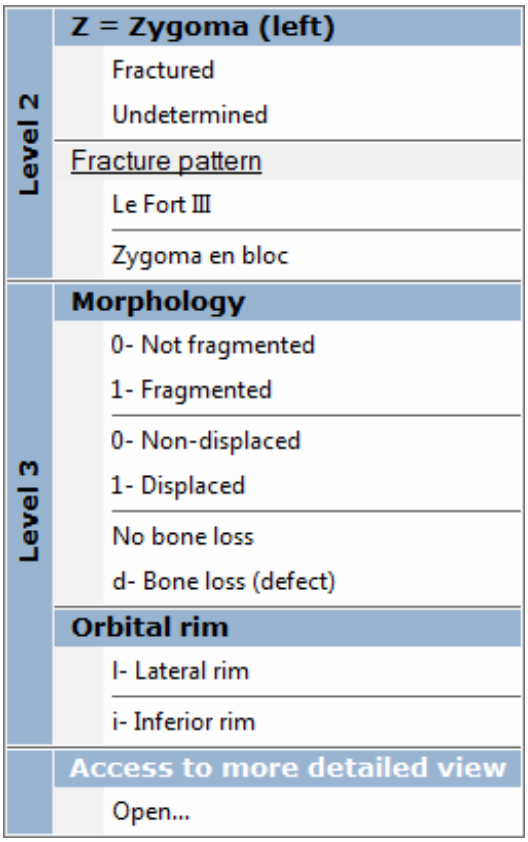
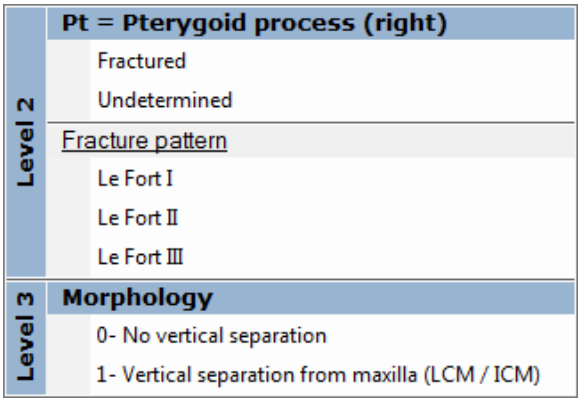
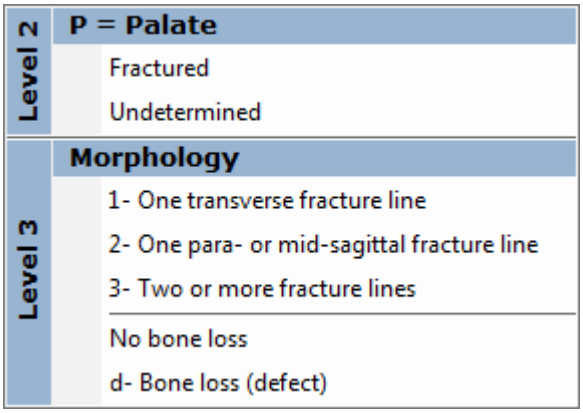


Figure 32







The classification menu windows specific to the orbit regions (orbital walls and apex) are presented in Figure 33.

At the bottom of all menu windows, except that of the Lower Central Midface (LCM) and Pterygoid process, an option allows accessing directly the detailed panoramic view of subregions (Figure 29) by clicking on "Open…"

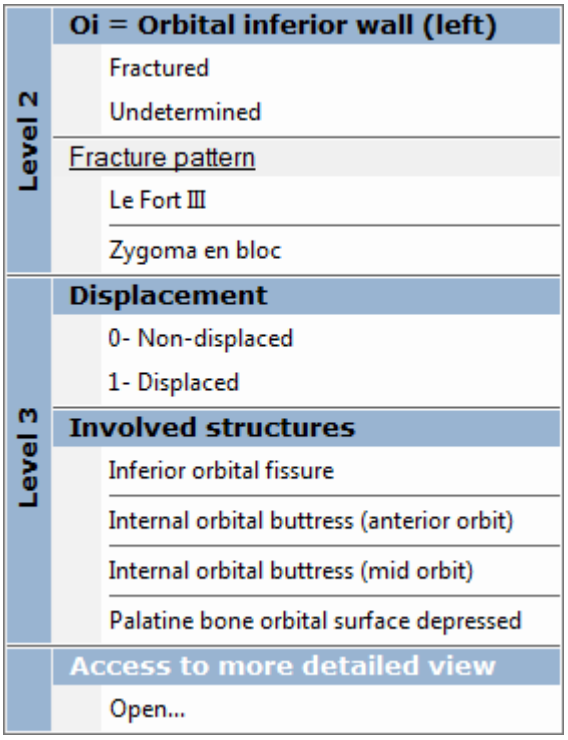
4.2.1. Dentition and atrophy

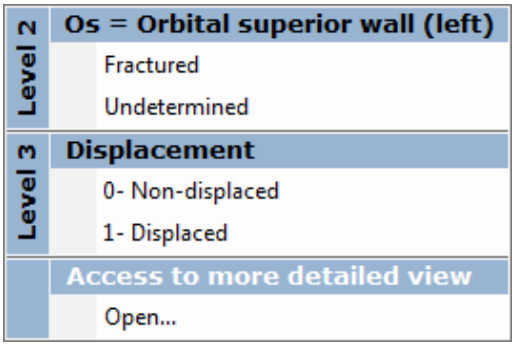
The dentition status at the lower central midface can be specified similarly to that of the mandible. The user should refer to that section (3.1.1) for more details. A level of atrophy can be recorded in one of three categories (see LCM in Figure 31) when at least one tooth is set as absent before trauma (see section 3.1.2).

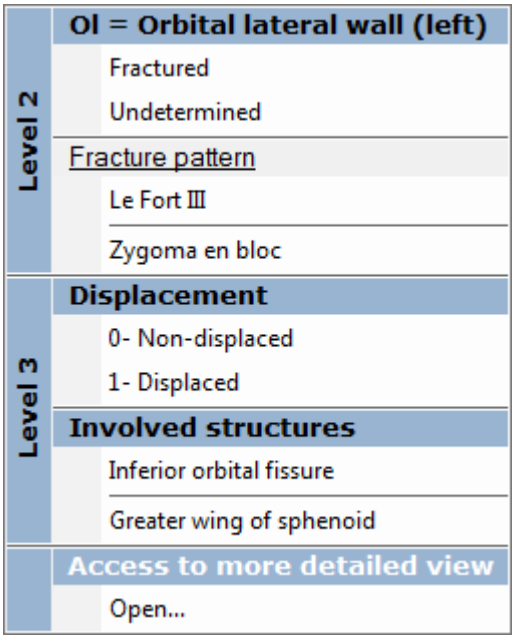
4.2.1. Alveolar process fractures

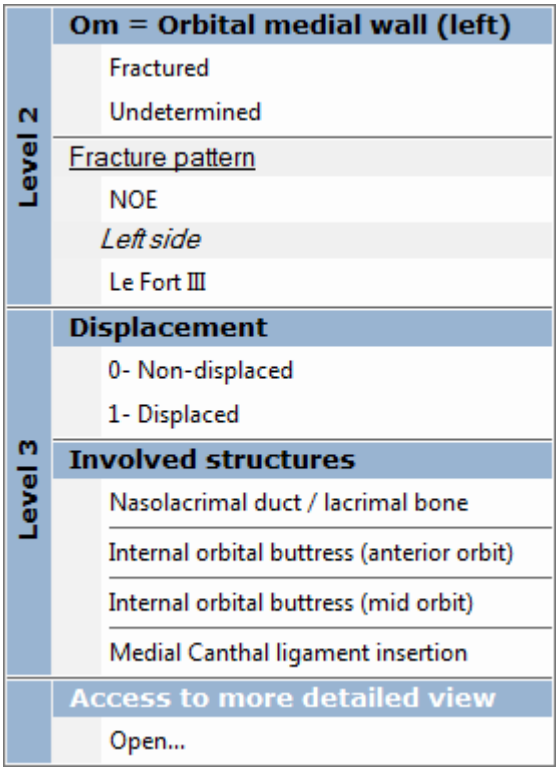
Alveolar process fractures can be documented at the lower central midface similarly to those in the mandible (see section 3.1.3)

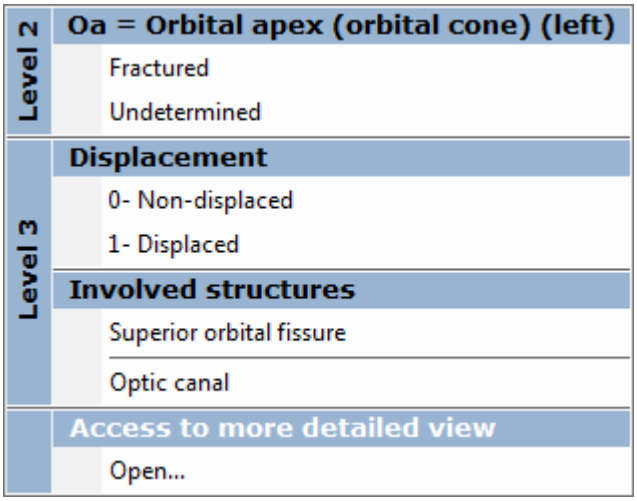
Figure 33


Level 2
Oi = Orbital inferior wall (left)
Fractured
Undetermined
Fracture pattern
Le Fort III
Zygoma en bloc
Level 3
Displacement
0- Non-displacked
1- Displaced
Involved structures
Inferior orbital fissure
Internal orbital buttress (anterior orbit)
Internal orbital buttress (mid orbit)
Palatine bone orbital surface depressed
Access to more detailed view
Open...


Level 2
Os = Orbital superior wall (left)
Fractured
Undetermined
Level 3
Displacement
0- Non-displaced
1- Displaced
Access to more detailed view
Open...


Level 2
Ol = Orbital lateral wall (left)
Fractured
Undetermined
Fracture pattern
Le Fort III
Zygoma en bloc
Level 3
Displacement
0- Non-displaced
1- Displaced
Involved structures
Inferior orbital fissure
Greater wing of sphenoid
Access to more detailed view
Open...


Level 2
Om = Orbital medial wall (left)
Fractured
Undetermined
Fracture pattern
NOE
Left side
Le Fort III
Level 3
Displacement
0- Non-displaced
1- Displaced
Involved structures
Nasolacrimal duct / lacrimal bone
Internal orbital buttress (anterior orbit)
Internal orbital buttress (mid orbit)
Medial Canthal ligament insertion
Access to more detailed view
Open...


Level 2
Oa = Orbital apex (orbital cone) (left)
Fractured
Undetermined
Level 3
Displacement
0- Non-displaced
1- Displaced
Involved structures
Superior orbital fissure
Optic canal
Access to more detailed view
Open...

4.2.2. Fracture patterns

Fracture patterns are part of the Level-2 system of the midface. Three fracture patterns can be specified from the menu windows depending on the involved regions:

- Le Fort (LF) type I, II and III
- Zygoma en bloc (ZEB)
- Naso-orbito-ethmoidal (NOE)

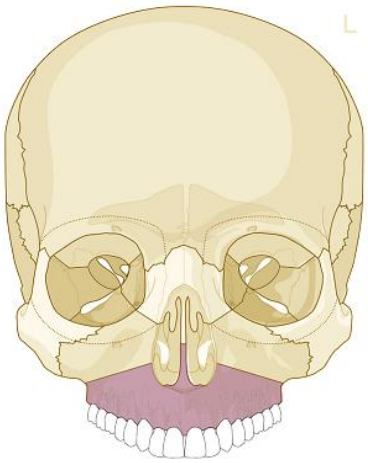
While the NOE pattern is central, both Le Fort and ZEB patterns can be specified separately on either or both sides.

- On any side the Le Fort I, II and III patterns are exclusive, i.e. they cannot be combined.
- The NOE pattern can be combined with ZEB and/or Le Fort I patterns.
- The ZEB pattern can be combined with Le Fort II or Le Fort I (with or without NOE) patterns

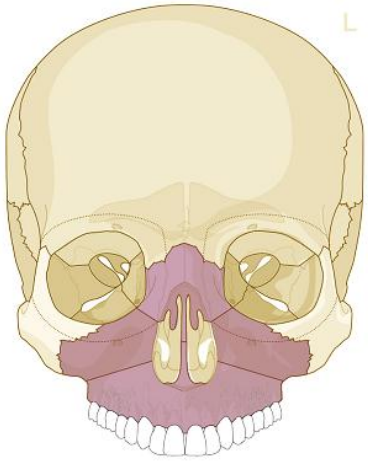
The regions involved in any specified pattern or associated patterns are highlighted in purple, such as bilateral Le Fort patterns (Figure 34). NOE and Zygoma en bloc patterns are also illustrated within the detailed panoramic view.

Figure 34

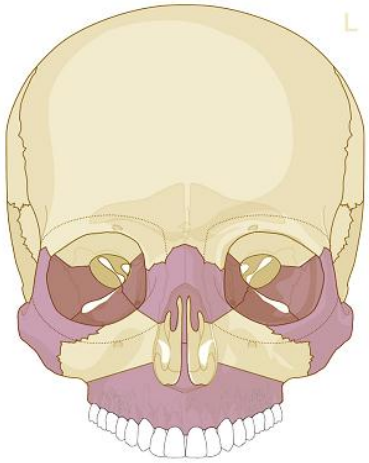
Le Fort I



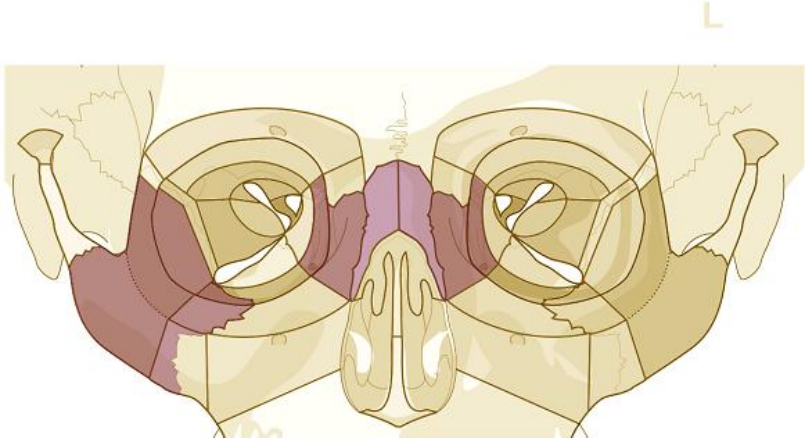
Le Fort II



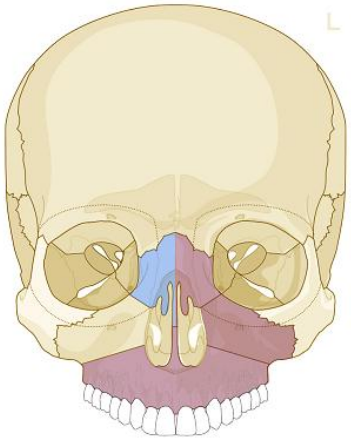
Le Fort III



NOE and Zygoma en bloc



Le Fort I and II



4.2.1. Fracture morphology

Fracture morphology is specified by Level-3 parameters that are described in the tutorial papers by Cornelius et al (midface)(8) and by Kunz et al (orbits)(9), respectively.

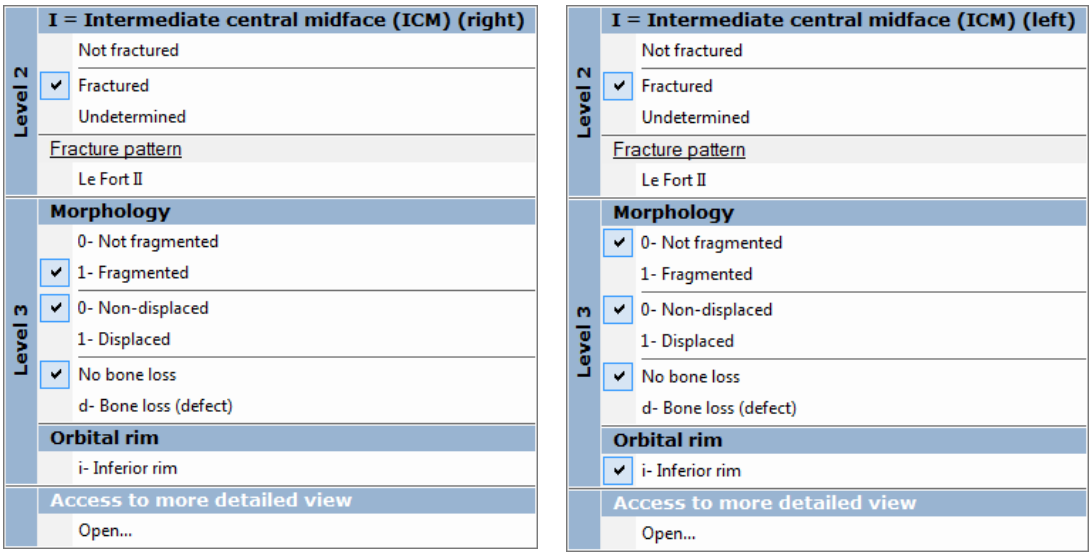
Central midface and Zygoma

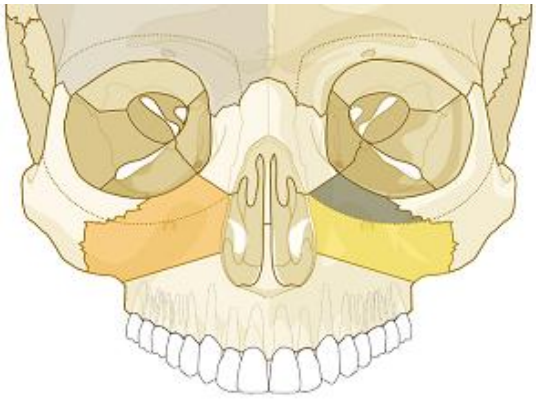
Fractures in the LCM, ICM, UCM and Zygoma regions can be described according to three parameters:

- Fragmentation: 0 = Not fragmented / 1 = Fragmented
- Displacement: 0 = Not displaced / 1 = Displaced
- Bone loss: d = bone loss (defect).

Regions with non-fragmented and fragmented fracture are coloured in yellow and orange, respectively (Figure 35). Those diagnosed with bone loss (d) are marked with additional stripes superimposed to the color scheme of fragmentation as illustrated for the mandible (Figure 18). Fracture displacement is not represented graphically however, although recorded in the AO COIAC database when documenting patients.

Figure 35



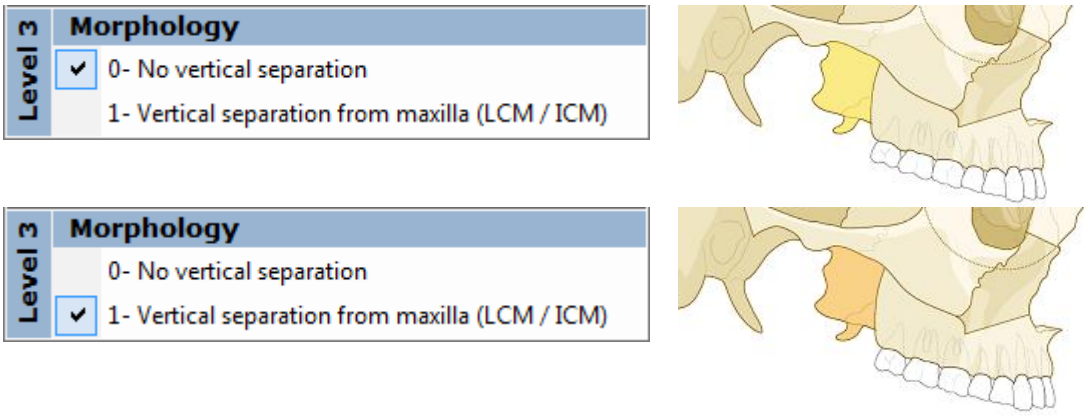


The regions ICM, UCM and Zygoma include part of the orbital rims that can be selected within the respective classification menu windows when fractured. The affected rims are darkened when selected (Figure 35):

- ICM : i = inferior rim
- UCM : m = medial rim (left / right)
- Zygoma : i = inferior rim, and l = lateral rim

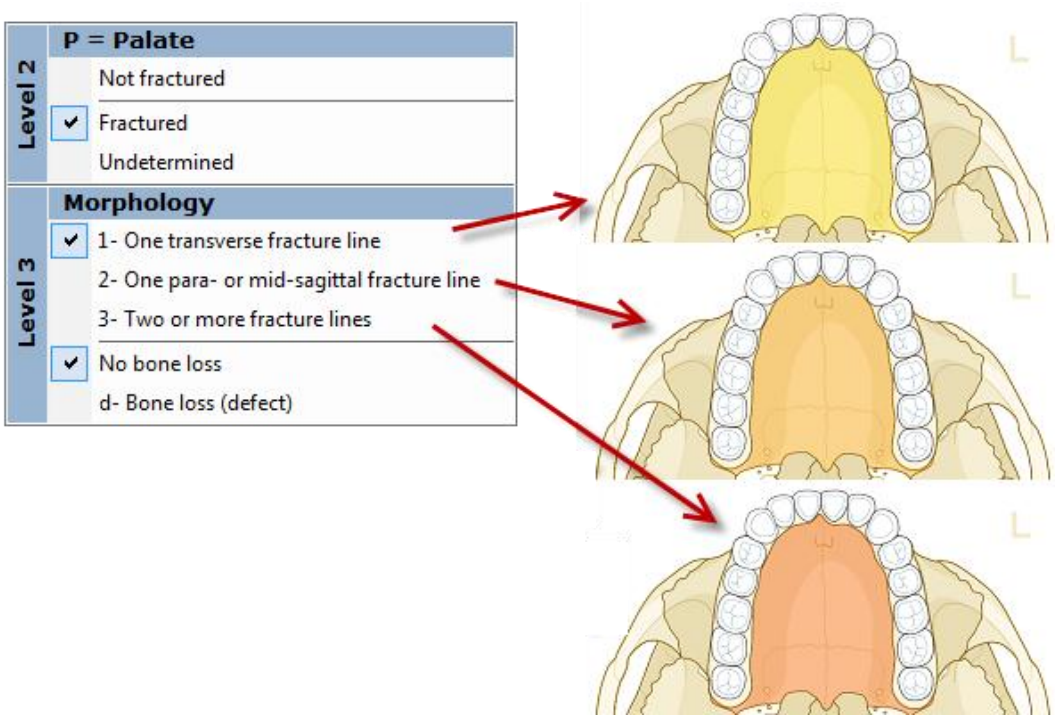
The Pterygoid process can be classified as being separated vertically from the maxilla (orange colour) or not (yellow colour) as the only Level-3 classification parameter (Figure 32 and Figure 36).

Figure 36



A fractured palate can be further described with regard to the course of the fracture line(s), as well the occurrence of bone loss (Figure 37).

Figure 37

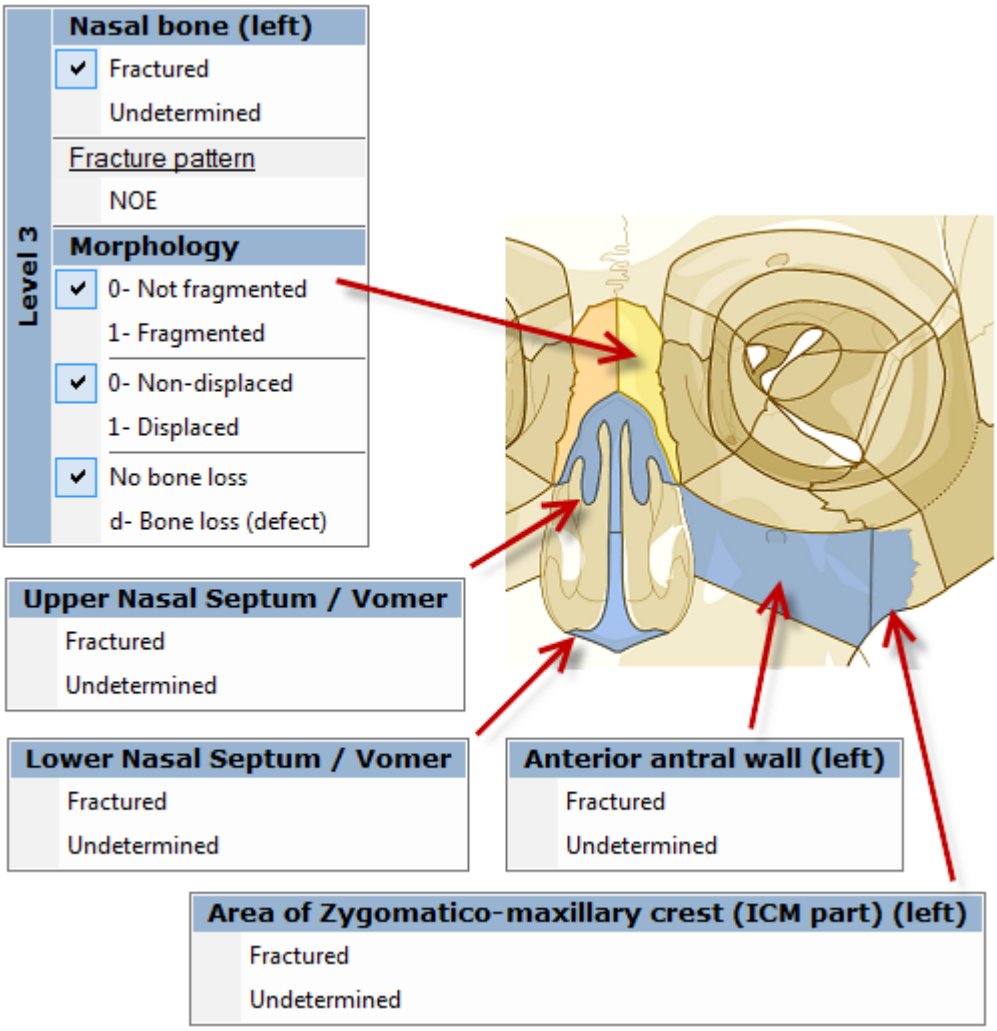


The detailed panoramic view of the subregions of the midface offers a mapping of the subregions for more refined classification.

- Subregions of the UCM include the medial orbital rims (presented in a subsequent section) and the nasal bone and the upper nasal septum. Fractures of the nasal bone can be specified as fragmented (highlighted in orange) or not fragmented (highlighted in yellow), displaced or not displaced, as well as with bone loss (d = defect)(Figure 38).

- The lower nasal septum belongs to the LCM; the anterior antral wall and the highlighted part of the area of zygomatico-maxillary crest belong to the ICM.

Figure 38

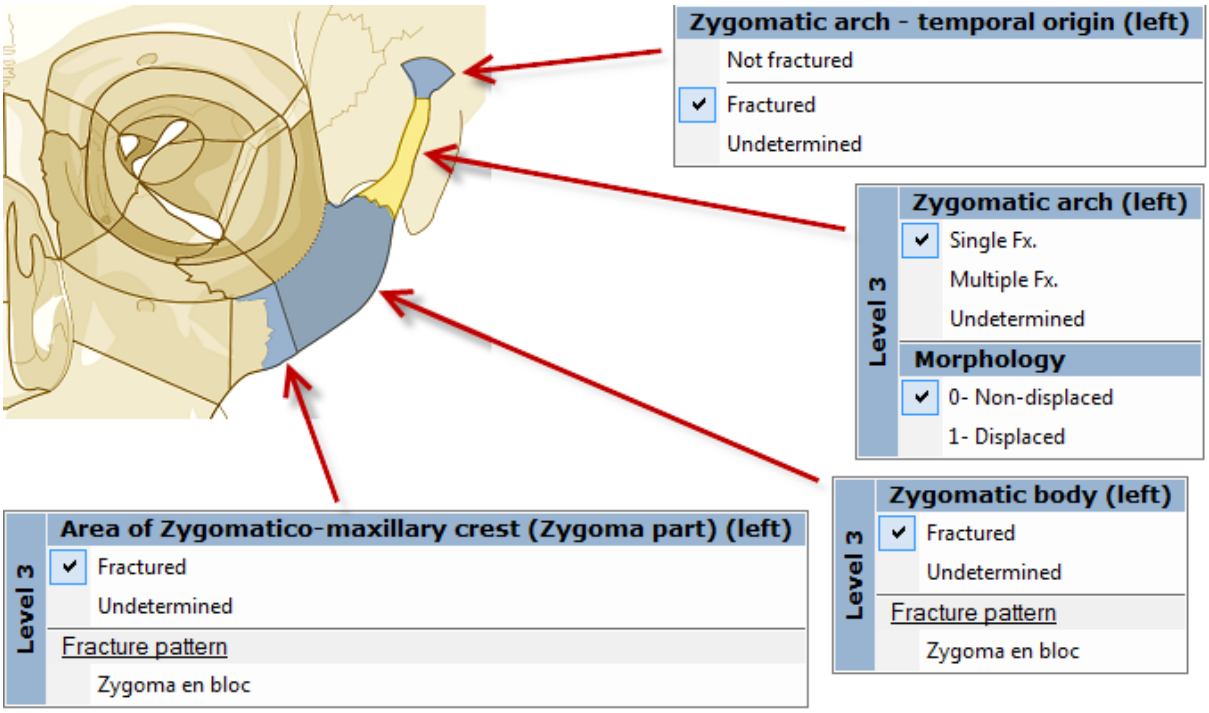


- Subregions of the Zygoma include an area of the zygomatico-maxillary crest, the zygomatic body, both being involved in the Zygoma en bloc pattern, as well as the zygomatic arch and its temporal origin (Figure 39).

  Zygomatic arch can have single (highlighted in yellow) or multiple (highlighted in orange) fractures, and the fracture(s) can be further described as displaced or not.

  Other subregions of the zygoma are presented in the following section along with other subregions of the orbits.

Figure 39

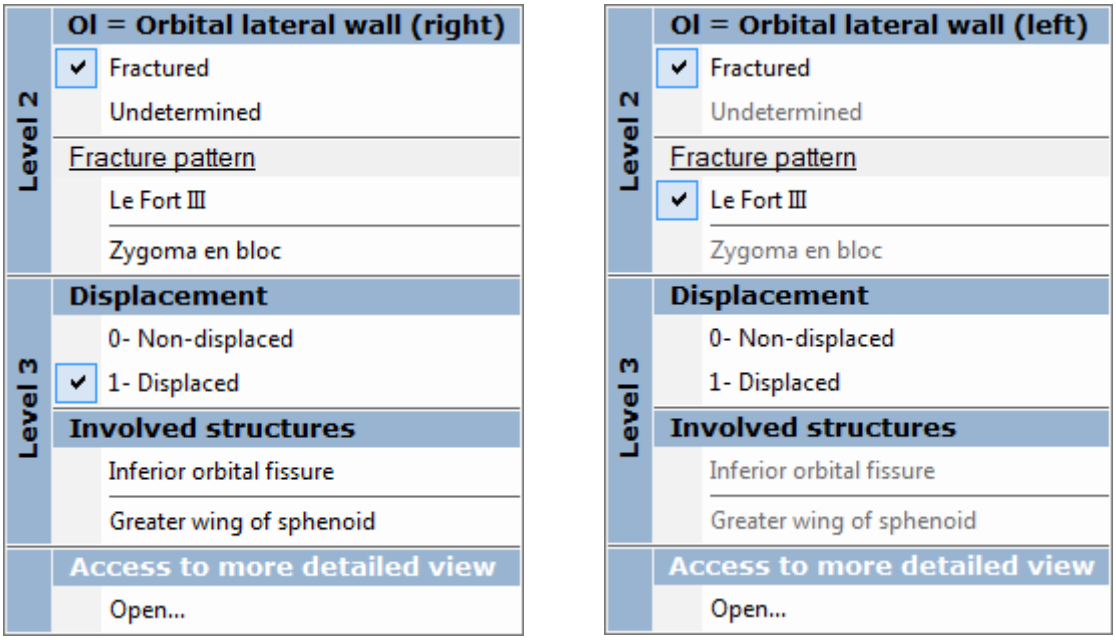


Orbit

As presented in the classification menu windows in Figure 33, fractures within orbital regions (walls and apex) can be described as being displaced or not. Displacement is not illustrated on the graphical display. In addition specific orbital structures can be selected as involved or not.

If a fracture pattern is selected (Le Fort III, NOE or Zygoma en bloc), the displacement parameter can be specified, however this attribute then concerns the whole pattern and not just the concerned region (Figure 40). In addition, no structures can be selected within the regions involved in the fracture pattern.

Figure 40



The detailed panoramic view of the subregions of the midface offers a mapping of the subregions for more refined classification (Figure 41).

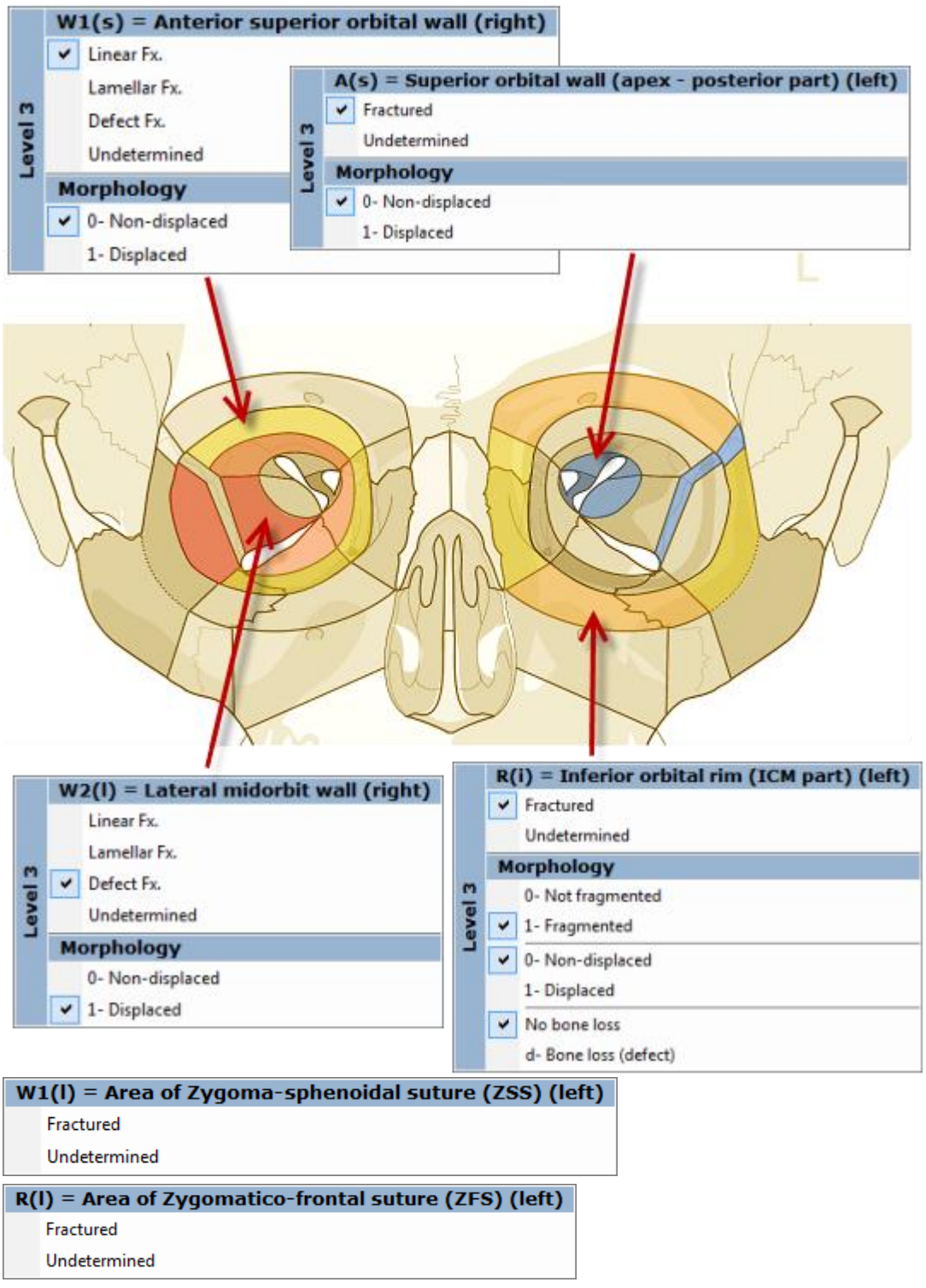
- Orbital rims can be described similarly to the midface regions LCM, ICM, UCM and Zygoma (Figure 35) according to fragmentation (Not fragmented / Fragmented), displacement (Not displaced / Displaced) and bone loss (defect).
  Regions with non-fragmented and fragmented fracture are coloured in yellow and orange, respectively. Those diagnosed with bone loss (d) are marked with additional stripes superimposed to the color scheme of fragmentation.

- The orbital walls can be specified as "Linear frature (Fx.)", "Lamellar Fx." or "Defect Fx." which are highlighted in yellow, orange and red, respectively, after classification.

While a linear fracture can be further specified as non-displaced or displaced, a lamellar fracture and a defect fracture are always classified as displaced.

- The three subregions of the apex, can be specified as non-displaced or displaced.
- The ZSS and ZFS subregions can be specified as fractured as shown in Figure 41.

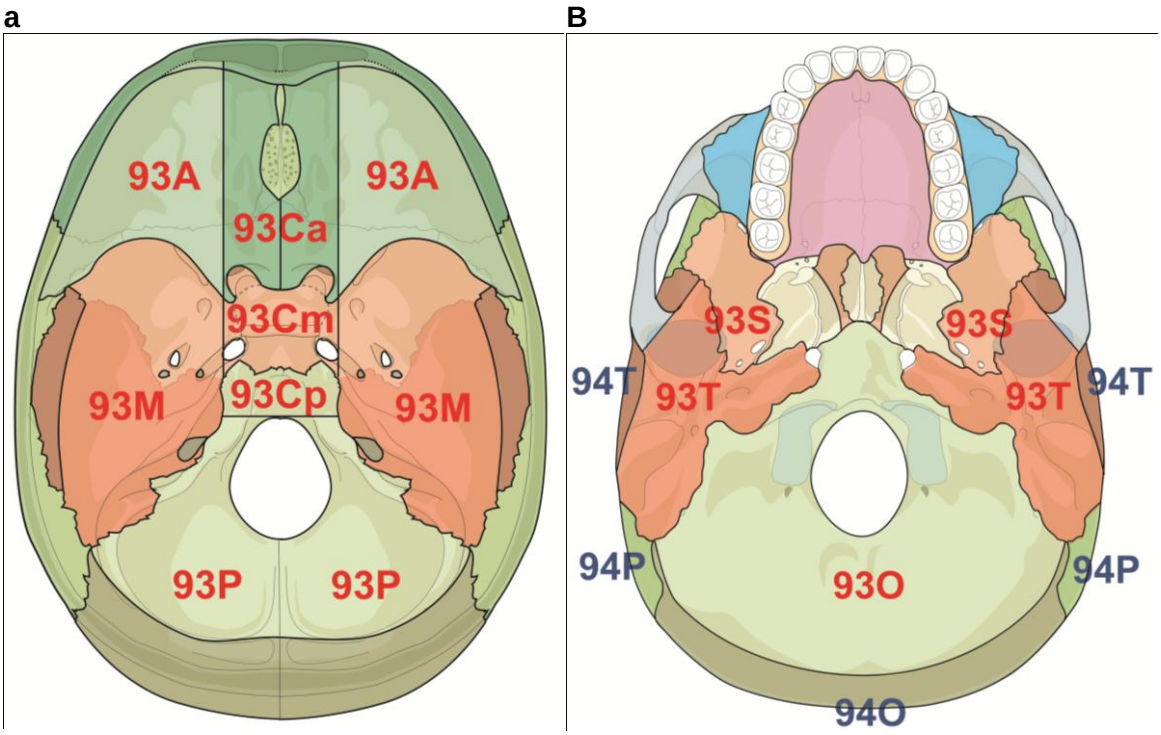
Figure 41



4.1. Fractures of the skull base (93)

The defined regions for the skull base are described in details by di Ieva et al (7) and illustrated in Figure 42 considering the endocranial (a) and exocranial (b) surfaces.

Figure 42



A = Anterior skull base; Ca = Central anterior; M = Middle; Cm = Central middle; P = Posterior; Cp = Central posterior; S = Sphenoid bone; T = Temporal bone; O = Occipital bone. ; P = Parietal bone (cranial vault)
Reproduced from di Ieva et al (7)

4.1.1. Endocranial surface

The classification menu windows specific to the endocranial surface.of the skull base are presented in Figure 43.

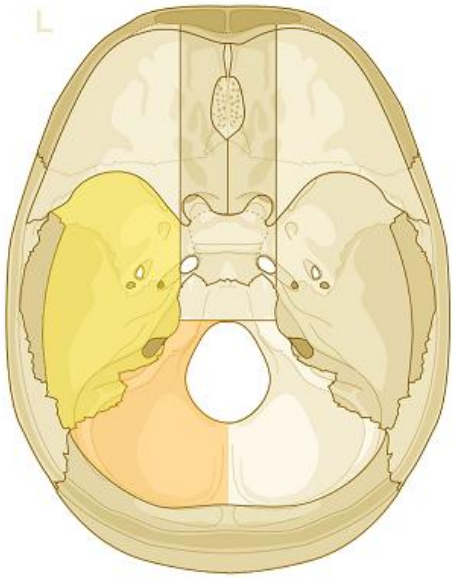
Each of the 9 regions can be classified according to fragmentation in 2 classes (not fragmented highlighted in yellow / fragmented highlighted in orange) and displacement in 3 classes (non-displaced / displaced but not depressed / depressed).

In addition specific structures can be selected as involved (fractured or opacification) within the central anterior skull base (ethmoid sinus on both sides, cribriform, frontal sinus) and central middle skull base (sphenoid sinus).

Figure 43

Level 2	M = Middle skull base (left)
	Fractured
	Undetermined
Level 3	**Morphology**
	0- Not fragmented
	1- Fragmented
	0- Non-displaced
	1- Displaced but not depressed
	2- Depressed

Level 2	M = Middle skull base (left)
	☑ Fractured
	Undetermined
Level 3	**Morphology**
	☑ 0- Not fragmented
	1- Fragmented
	☑ 0- Non-displaced
	1- Displaced but not depressed
	2- Depressed



Level 2	P = Posterior skull base (left)
	☑ Fractured
	Undetermined
Level 3	**Morphology**
	0- Not fragmented
	☑ 1- Fragmented
	0- Non-displaced
	☑ 1- Displaced but not depressed
	2- Depressed

Level 2	Ca = Central anterior skull base
	Fractured
	Undetermined
Level 3	**Morphology**
	0- Not fragmented
	1- Fragmented
	0- Non-displaced
	1- Displaced but not depressed
	2- Depressed
	Ethmoid sinus (left)
	Fractured
	Opacification
	Ethmoid sinus (right)
	Fractured
	Opacification
	Cribriform
	Fractured
	Frontal sinus
	Posterior wall fractured
	Opacification

Level 2	Cm = Central middle skull base
	Fractured
	Undetermined
Level 3	**Morphology**
	0- Not fragmented
	1- Fragmented
	0- Non-displaced
	1- Displaced but not depressed
	2- Depressed
	Sphenoid sinus
	Fractured
	Opacification

Level 2	Cp = Central posterior skull base
	Fractured
	Undetermined
Level 3	**Morphology**
	0- Not fragmented
	1- Fragmented
	0- Non-displaced
	1- Displaced but not depressed
	2- Depressed

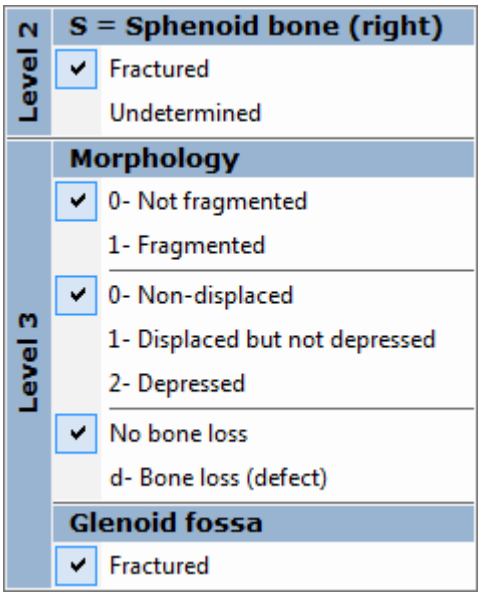
4.1.1. Exocranial surface

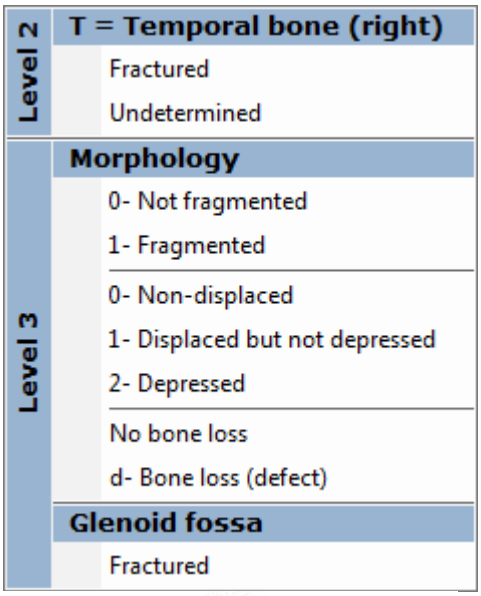
The classification menu windows specific to the exocranial surface.of the skull base are presented in Figure 44.

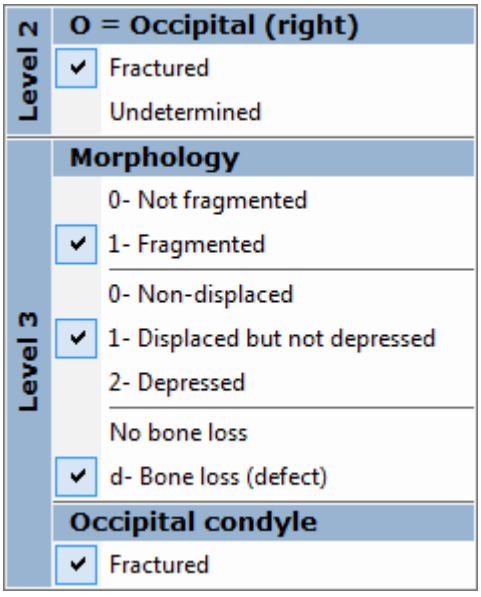
Each of the 6 regions S, T and O can be classified according to fragmentation in 2 classes (not fragmented highlighted in yellow / fragmented highlighted in orange) and displacement in 3 classes (non-displaced / displaced but not depressed / depressed) similarly to the endocranial surface. In addition bone loss (d = defect) can be specified.

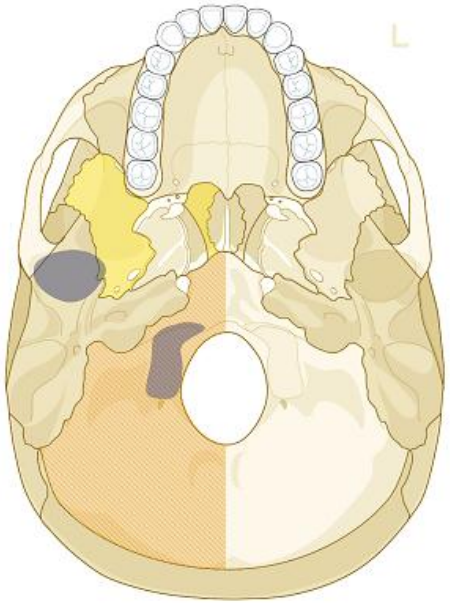
Glenoid fossa fractures can be noted as involving the sphenoid and/or the temporal bone, and fractures of the occipital condyles are noted within the occipital region

Figure 44





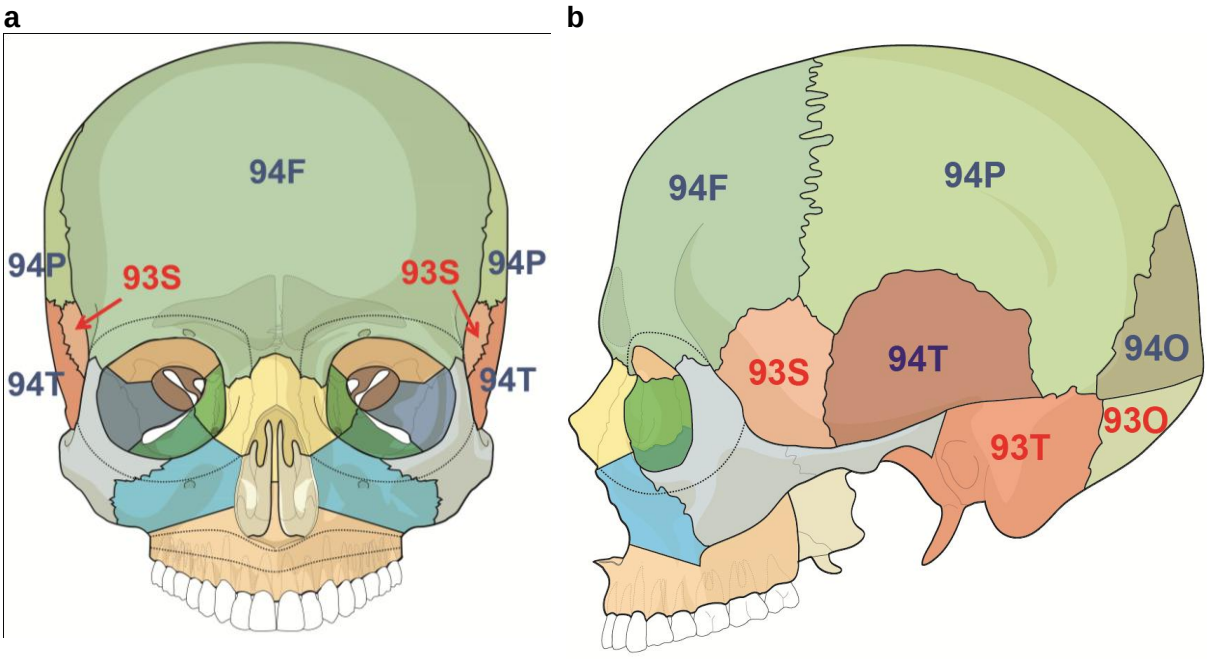




4.2. Fractures of the cranial vault (94)

The defined regions for the cranial vault are described in details by Di Ieva et al (7) and illustrated in Figure 45.

Figure 45



F = Frontal bone; T = Temporal bone; P = Parietal bone; O = Occipital bone;
S = Sphenoid bone (skull base). Regions labelled in red are from the skull base.
Reproduced from di Ieva et al (7)

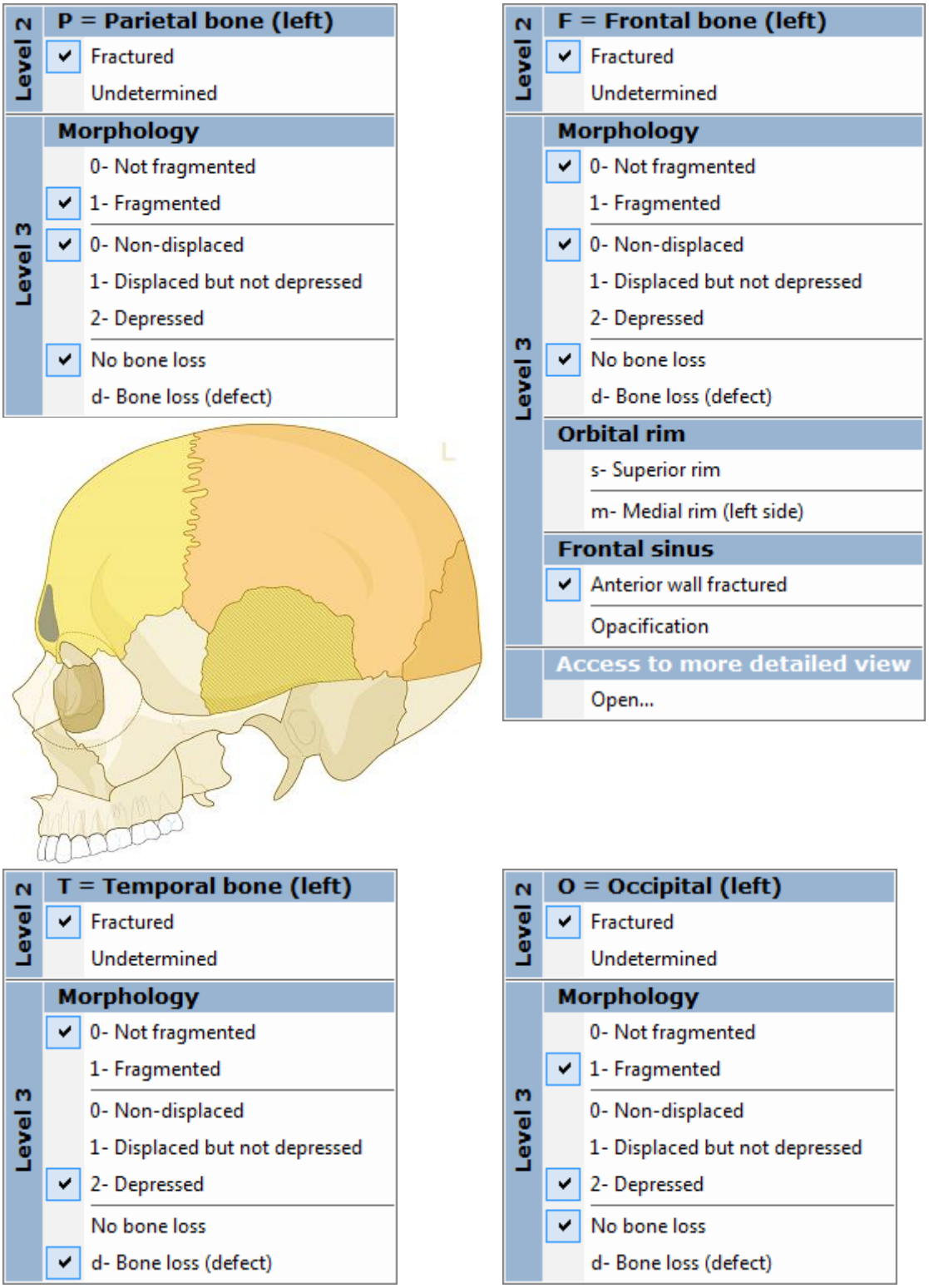
The classification menu windows specific to the cranial vault are presented in Figure 46.

Each of the 4 regions F, P, T and O can be classified according to fragmentation in 2 classes (not fragmented highlighted in yellow / fragmented highlighted in orange) and displacement in 3 classes (non-displaced / displaced but not depressed / depressed). In addition bone loss (d = defect) can be specified and highlighted with stripes over the color scheme.

Involving the frontal bone, the superior and part of the medial orbital rims can be selected as being fractured; their detailed classification can be further performed from the detailed view that can be accessible directly from within the menu window of the frontal bone (click on "Open…" just below "Access to more detail view (see Figure 41).

Note = The classification of subregions within the detailed view is not initiated by fracture classification within the region (the only exception is for the zygoma en bloc fracture pattern as described in section 4.2.2).

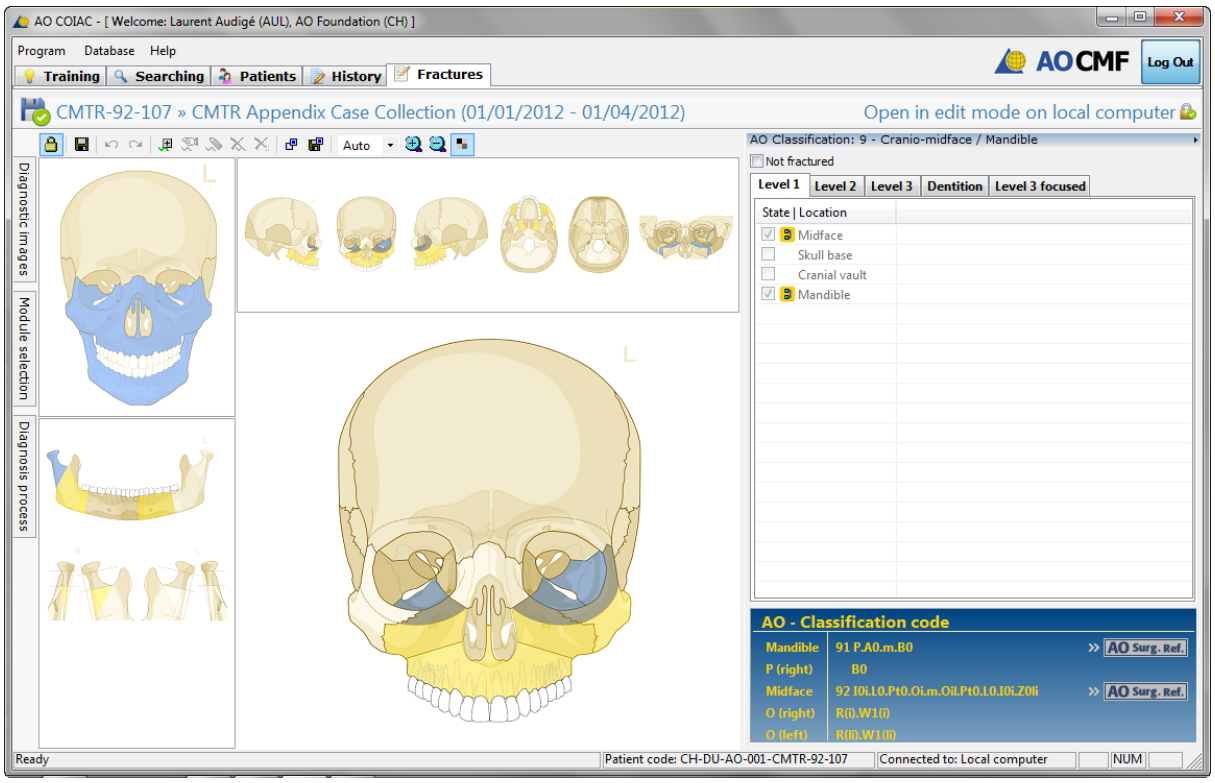
Figure 46


Level 2
P = Parietal bone (left)
Fractured
Undetermined
Level 3
Morphology
0- Not fragmented
1- Fragmented
0- Non-displaced
1- Displaced but not depressed
2- Depressed
No bone loss
d- Bone loss (defect)
Level 2
F = Frontal bone (left)
Fractured
Undetermined
Level 3
Morphology
0- Not fragmented
1- Fragmented
0- Non-displaced
1- Displaced but not depressed
2- Depressed
No bone loss
d- Bone loss (defect)
Orbital rim
s- Superior rim
m- Medial rim (left side)
Frontal sinus
Anterior wall fractured
Opacification
Access to more detailed view
Open...
Level 2
T = Temporal bone (left)
Fractured
Undetermined
Level 3
Morphology
0- Not fragmented
1- Fragmented
0- Non-displaced
1- Displaced but not depressed
2- Depressed
No bone loss
d- Bone loss (defect)
Level 2
O = Occipital (left)
Fractured
Undetermined
Level 3
Morphology
0- Not fragmented
1- Fragmented
0- Non-displaced
1- Displaced but not depressed
2- Depressed
No bone loss
d- Bone loss (defect)

4.3. Fracture code and Surgery Reference

After completion of the classification, the fracture code is presented within the bottom-right screen window (Figure 47). The codes can be copied to the computer clipboard following double-click of the mouse over them.

Figure 47



Mandible 91 P.A0.m.B0
P (right) B0
Midface 92 I0i.L0.Pt0.Oi.m.Oil.Pt0.L0.I0i.Z0li
O (right) R(i).W1(i)
O (left) R(li).W1(li)

Direct access to the AOCMF Surgery Reference portal at a remaining basic level of the classification is provided by selecting the appropriate icon "AO Surg. Ref." on the right of the fracture code.

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The Pediatric Classification Group (PACG) coordinated and supervised the development of this AO COIAC database extension.

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Theddy Slongo (CH)	Medical expertise – Module long bones for children
Peter Cornelius (DE)	Medical expertise – CMF Module
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